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THE CHALLENGE*

BY WALTER MULFORD

Professor of Forestry, University of California

(May we now think together of The Challenge? And when we have finished, instead of courtesy-applause, may I ask that we sit in silence for a moment, making our thoughts strictly our own. Because to me the challenge that is upon us calls for what is deepest in us.)

Team-Mates Who Together Must Meet the Challenge of the Next Quarter-Century:

Said Jim: "The English made us write the Declaration of Independence and they also gave us the steam-engine with which we made our independence good." But Michael, instructed by his study of the lives of the leaders in his adopted country, suggested to Jim that the steam-engine without great men behind it would have been of little consequence. "Yes," said Jim, "the Declaration of Independence without men of character and brains behind it would also have been of little avail; and the great aims of the Civil War without men like Lincoln and Grant behind them would have ended in a foolish fizzle. This country, my lad," exclaimed Jim with much warmth, "is a monument to the lives of the men of brains and character and action who made it."¹

Jim was the humble fireman in the boiler room of the New England Cracker Factory in Cortlandt Street, New York. His friend was Michael Pupin, a young Serbian peasant who, as he himself expresses it, was in the process of having the mist removed from before his eyes as to the real meaning of America. The conversation occurred a half-century ago. Mr. Pupin is now the eminent professor of electro-mechanics in Columbia University.

*President's address, annual meeting of the Society of American Foresters, Washington, D. C., Dec. 30-31, 1924.

¹Adapted from "From Immigrant to Inventor," by Michael Pupin.

The Society of American Foresters, founded in the autumn of 1900, is now in its twenty-fifth year. It seems fitting that at this, our last annual meeting before entering the second quarter-century lap of our service to America, we should pause to set the compass. From various angles, as itemized in the program, we shall remind ourselves of the trail we have travelled and attempt to outline with broad strokes the widening highway that we shall strive to open across the unknown ridges and canyons of the years from 1925 to 1950.

And be it said in passing that strenuously though we must blast for the highway, we shall remember the trail with deep affection. Despite its difficulties our pioneer-path has been a happy place, and we shall dream of it when intensive silviculture, fine-spun working plans and a fully-recognized profession shall have ousted the wilderness which was our first love.

My part in the orientation is the forester himself. What manner of man has he been? What is he now? What next for him?

It is not easy to see ourselves professionally as others see us. But this morning let each of us try to think of our team-mates in a detached way. For the moment we are mechanical engineers or merchants, appraising in a friendly way this new colleague, the forester. As yet he has been only slightly felt as an element in American manhood. Shall he be taken into full fellowship among the strong men who make the real America?

What of his past? Aside from a handful of stalwart forerunners, he appeared in America about 1900. In his early years, service—public service—was written on his heart in what it was hoped would be indelible characters. And the spirit of the pioneer was his. Without these two qualities, in those days, he would not have been.

As the years went on, these characteristics became cherished ideals. Today they are traditions, priceless traditions of our profession; bright and effective as ever in some of us; perhaps at times dim and wavering in others of us; but always there, underneath, able to carry us onward if we will but put ourselves in communion with them. May America's future foresters remember this debt to forestry's first quarter-century on our shores. And may they be worthy of the two-fold heritage.

What is he today? Proud of his traditions. Trying to live up to them—in varying degrees, as is the way of mortals. Failing sometimes in the clearness of his conception as to the deep meaning of the pioneer tradition; as when he feels that his technical college

training has been wasted just because he finds that as yet he can use few of the facts that he has learned—the poor, superficial facts! Prone to feel that the way does not open as fast as it should: a good trait when he recognizes that the fault is his alone; an unworthy one when he ascribes the cause to others. Apt to be discouraged because what may have required two hundred and fifty years to achieve elsewhere has not arrived here in twenty-five.

Most of all, let us question another of his characteristics as he stands at the threshold of 1925. In general, in my judgment, he is *not the master workman* that we must have in what lies just ahead.

As teachers, we teach neither so fundamentally nor so well as in the better schools of medicine. As scientists, we have, of course, not yet reached the heights attained by physicists and chemists. As administrators we have necessarily not yet gotten the breadth and the business ability which must be ours before forestry can fully come into its own.

In all of this no discourtesy is intended. In each group there are outstanding exceptions, men of high ability. And the profession is young, and must have time to get on its feet. There is here no spirit of criticism. But if the situation is as stated, we should face it, and individually remedy it.

A contributing cause may be that many of us have not forced the development of our own powers. A large proportion of us are in government service, or in educational and scientific institutions, where, say what you will, we are not compelled by rough-and-tumble struggle with our competitors to achieve the same degree of keenness and effectiveness that necessarily characterize the typical successful engineer or manufacturer. Let us make no mistake here, however. It does not necessarily constitute an objection to governmental or educational work. Many of the ablest men in all fields of endeavor are in such positions. But has their ability not come from within themselves, from their will power, faithfully exerted despite the fact that the mere holding of the job and some advancement in it may not have required every ounce that is in them? The fact of relative protection does not inhibit the development of great powers; but it does entail an added responsibility to impel one's self.

I wish we could know the relative average annual effectiveness of one hundred members each from the Society of American Foresters and the American Institute of Electrical Engineers. If such a comparison were possible, my fear is that we might not be proud of the result.

I may be mistaken. I hope I am. Whether I am or not is relatively immaterial. If we are now on a par with others who have had similar opportunities for training, well and good; it is then for us to progress at least as fast as they are developing. If we are below par, our task is the greater. In any event *we must now qualify as a profession of the first rank in ability*, as we have already done in self-sacrificing public service.

Despite whatever failings we may have had, the situation on January 1, 1925, is wonderfully good, particularly as viewed from the standpoint of those of us who remember all too well the faintness of the first beginnings. Yes, I know you may be saying the situation is not good; so little has been done; so much suffers because of the many unfortunate and untouched situations that cry out for strong men to take hold. But I say again we have travelled far in twenty-five short years—farther, I believe, than we had dared to hope. One can not start almost at zero and in so brief a time have taken more than the first steps in so great a task.

Said Jim: "This country, my lad, is a monument to the lives of the men of brains and character and action who made it." We have travelled so far in forestry only because of "the men of brains and character and action" whom we have numbered among us. Stop a moment; suppose American forestry had had none of the group of outstanding men whom you will easily call to mind; without men of their caliber forestry would now be only over the first low ridge beyond its status in 1900, instead of well up in the foothills. To mention only those who have begun their labors elsewhere, I thank God for such men as J. T. Rothrock of Pennsylvania, Charles H. Shinn of California, Bernhard E. Fernow of America, each in his own way a builder. And then, suppose we had not had a Theodore Roosevelt! Add to these the small number of names of those who are still among us who have builded in large terms—you know who they are; add to these again the effectiveness, minute or considerable, of all the rest of us, of every single man and woman of us who has striven: the result is the structure of January 1, 1925.

If the structure is not so large as you think it should have become, it is not fundamentally because any "vested interest" may have blocked the path, or our public been strangely indifferent. Blocking, and indifference, are to be expected as elements in the work which is ours to do. We are no farther advanced because we have not had more

strong men, and because the rest of us have not been more nearly master workmen, no matter how humble our niche.

Cease blaming others; forestry is ours to make or retard. We should feel a sense of personal shame in any complaint that forestry should move faster. Forestry can not move of itself. The responsibility is clear.

My judgment is that, on the whole, with respect to the period now closing, we may say, "Well done." But I have a distinct uneasiness as to what may be said in 1950 as to the years we now face.

The heavy train has started slowly. The time is here when the rate of speed should be greatly increased. Now that the start has been made for us, to travel as slowly as must be the case with the first pioneer and the departing train, would be to fail. Furthermore, we are in America, and in America things can come to pass in brief space when the power, the power of men, is present.

Before 1950, great tasks must have been completed, if again it shall be said, "Well done." Tasks in establishing forest policy; in making forestry a business success; in raising forestry to a worthy scientific standing; in many ways. *Above all, in making sure that the forester himself is unmistakably established on a plane second to no other calling in personal character, in breadth of vision, in master workmanship.*

Do you realize that our plane is not yet established on any level whatever, except perhaps among ourselves, because we are so little known? And I fear we may rate ourselves too highly, because we may so little realize the ability existing in many fields.

In 1950, we may expect that forestry will be generally known, with its caliber and characteristics quite well established. It will have taken its place among professions in America. Let us not be overconfident as to what our position will be. We have a long trail to travel to put it where it belongs.

The responsibility is ours individually, and each five years of the quarter-century that our work is still here we should make a definite contribution. A five-year personal working plan, revised as conditions change and storms cause wreckage, may help me to keep tab of myself.

In what field shall I make my contribution? In any, so long as it be worthy.

What are my tasks? Among others, these three: First, to ingrain in myself two visions: the four hundred seventy million acre, sixty

cubic feet per acre per annum American forest; and the full-grown American forester, come into his own. The area may prove to be other than four hundred seventy million acres; its productive capacity may be greater or less than sixty cubic feet: no matter; in any case it is a tremendous task, a great vision, demanding our best. Its realization will require more than silviculture. Before it can come to pass there must be men, big men, many of them.

And the other vision, that of the forester second to none in the land? It shall not be otherwise. Such is our will.

My second task: to prove our traditions in my own life: service; the pioneer spirit. Even for the pioneer spirit, the need does not lessen. America does big things, in a large way, when the need is patent. A Panama Canal? Why not several billions of dollars, if necessary, to get forests going in America, NOW? America has pioneered for the world in many items, in ideals of government, in business organization, in philanthropy. Why not in forestry? Pioneering in silviculture, in forest regulation, in utilization; in the scientific basis of forestry, where all is pioneering. The day of the pioneer is ever with us.

The last of these three tasks of mine: to be a master workman, or as near it as I can, even though I be on the humblest round of the ladder. To attain this requires sustained self-discipline. And the process should greatly increase, not crush, the joy of life.

A man, rendering service, the best there is in him. That much each of us can do, no matter how limited his capacity. It is a big thing to have done, with all honor in it. *An outstanding man, rendering outstanding service*. Not many of us can be thus. But there is the responsibility to leave no stone unturned in the effort to attain it. *A leader among outstanding men, leading in outstanding service*. How many by 1950?

The forestry of 1950 can be no greater than the sum of the lives of all these. Where you or I individually shall be in the scale matters little, so long as it is the full measure of the best that in us lies.

The challenge of 1925-1950 rings out. If you have in you anything of the fire of the spirit of 1900, rise to it. I wish that each of us, sometime during the next ten days, when alone, in the quiet, might accept the challenge, pledge himself anew, and make the first entries in his personal working plan for the coming quarter-century.

The challenge rings out, and rings again. So shall our answer ring!

THE RELATIVE LIGHT REQUIREMENTS OF SOME CONIFEROUS SEEDLINGS*

By C. G. BATES

Rocky Mountain Forest Experiment Station

THE PROBLEM

It is a fact well-known to almost everyone who has given attention to the literature of forestry, that a concept of a marked difference between species or genera in their light requirements,—or we may say, in their capacities to synthesize carbohydrates in reduced light,—is fundamental to the art of silviculture as it has been developed empirically. This concept is of the utmost practical importance, for on such differences between the species as do exist depend the outcome of mixed plantations, of plantations made under the canopies of old trees which do not reproduce themselves, and of all those natural phenomena, which we may denote by the single term "succession," and through which the character of the forest may gradually change, one species giving place to another.

Physiologically speaking, there is a serious doubt as to the extent to which variations in photosynthetic capacity between species, or even between widely separated groups of plants, actually exist. At least so far as the forest concept is concerned, it has been derived very largely from observations in nature where a great many factors other than light enter into the result. The most obvious fact is that in nature light available for the individual plant is commonly decreased by crowding of individuals, and as this crowding is accentuated the competition for soil space and soil moisture becomes increasingly keen. Death or impoverishment which is readily ascribed to the lack of sunlight may in reality be due to lack of moisture or nutrients. That this is almost inevitably a factor in nearly every instance is indicated by a second axiom of forestry, which says that a given species requires more light on a poor site than on a good site, or in other words will tolerate more crowding where the soil conditions are more favorable. Still another indication of the importance of soil space is the almost universal conclusion that trees require more light as they become older. Otherwise interpreted this may merely mean that the larger tree can not be satisfied with some little handful of unoccupied surface soil.

*Paper presented at Pacific meeting of Botanical Society of America, Portland, Oregon, June 18, 1925.

Again I may point out briefly that where direct sunlight is lacking, there also temperatures may be unduly low for processes in the plant other than photosynthesis. However, as I see it, since photosynthesis is itself somewhat dependent on temperatures, this factor is not likely to have greatly confused the real issue.

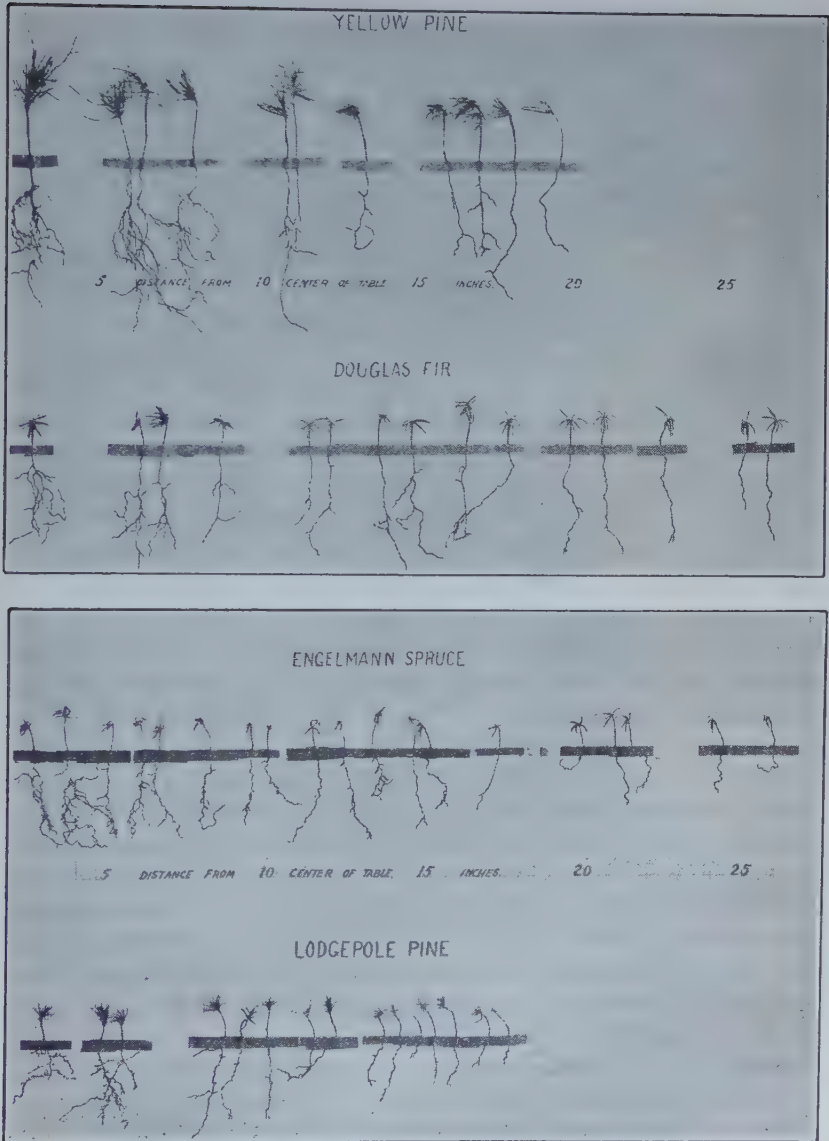
In this discussion I have merely attempted to cover the field in a broad way so as to give you some idea of the need for controlled experimental evidence on the importance of light *per se*. If light is not the most important cause of the phenomena observed in the forest, but rather soil moisture and nutrients, then certainly foresters should know it, and should not continue to build their practice on the foundation of a faulty conception, which under one circumstance or another is certain to crumble.

I can not attempt in the present paper to go into the subject of selective absorption of rays by the foliage of trees, except merely to mention the fact that evidence secured by Zederbauer¹ and others suggests a greater utilization of the red or heating rays by the so-called light-demanding species and of the blue and violet rays by those which are shade-tolerant. Here again we meet the problem of actual differences in heat requirements which may affect other processes as well as photosynthesis.

Of actual experimental work done with a view to comparing the light requirements of trees, with other factors under control and either optimum or otherwise, there has been a marked paucity, due largely, no doubt, to a lack of the necessary instruments and paraphernalia for carrying on such tests by those most interested in this subject. I shall mention, and that briefly, but one rather recent piece of work which to my mind approaches completeness in experimental detail. Burns, of the Vermont Agricultural Experiment Station,² observed a number of forest tree seedlings (both eastern hardwoods and eastern and western conifers, 18-24 inches high) under bell-jars, lighted by two incandescent lamps (Nela "Trutint" 750-watt Nitrogen) whose distance, and hence intensity of light, could be readily controlled. By measuring the production of CO₂ for 3-hour periods, at distances varying from 22 to 96 inches, and intensities (related to the heating value of sunlight at noon December 22 as measured by a thermo-couple and potentiometer) varying from 1.6 to 25.1 per cent, he was able to deter-

¹ 1907: "Das Lichtbedurfniss der Waldbaume." *Centralblatt ges. Forstwesen* 33: 325-330.

² Bulletin 235, 1923. "Minimum Light Requirements Referred to a Definite Standard."



These views of sample seedlings from various parts of the table, arranged according to the light intensities which they received, show clearly how greatly the rooting vigor of the seedling is reduced when it is unable to make food, and thereby explain why shaded seedlings succumb under the competition for moisture which exists in the forest even where more than the absolute minimum of light is available.

mine approximately the minimum points at which any photosynthesis occurred. He obtained minimum light values varying from 2.0 per cent for sugar maple to 17 per cent for western yellow pine. For Engelmann spruce, which we consider one of the most tolerant of western conifers, he obtained a value of 5.9 per cent and for Douglas fir (*mucronata*) about 7.6 per cent. These values were obtained with a constant room temperature of 80 degrees F.

EXPERIMENTAL

The experiment I now wish to describe is of quite a different nature, less refined in its method, perhaps, than that of Burns, yet perhaps in some ways more satisfactory because of its long-term character, and the absence of extremely technical operations, such as the determination of the CO₂ content of the air, likely to introduce experimental errors. Briefly stated, the object was to determine the minimum light values under which seedlings might survive for an indefinite period after germination. This period was approximately 11 months.

A table five-feet square, placed in a section of the greenhouse, later completely darkened, was covered with a layer of approximately four inches of soil, one half of the soil used being a clean granitic sand, the other half of the same origin but loamy in texture. Since there was no difference in behavior on the two soils, except apparently an earlier damping-off of seedlings on the loam, this division need not be kept in mind.

Seeds of eight species were broadcasted over the entire area of the table, covered with a thin layer of soil, well watered, and allowed approximately half sunlight for about 20 days, while the greater part of the germination occurred. Some germination of lodgepole pine occurred after this time, which may in part account for the showing made by this species. At the beginning of the test, therefore, the seedlings were green, vigorous and very young, most of them barely having shed their seed-coats.

A 200-watt G. E. Mazda "Daylo" lamp was now suspended over the center of the table and at a distance of about six inches from the soil. It will readily be seen that the table was thereby automatically laid off in annular zones of varying light intensity, and that by recording the distance of each seedling from the center of the table, the essential step was taken to record the light intensity under which it grew constantly. The second step was to make a scale of light values corresponding to distance.

After beginning the use of the artificial light, the seedlings were given the light for 10 to 11 hours each day. At the end of six months it appeared that seedlings even at the corners of the table, 42 inches from the light, were likely to survive: it was therefore thought best to reduce the light intensity so as to cause a more distinct grading down, and a 75-watt Columbia Mazda blue-glass lamp was substituted for the 200-watt. During the last five months, therefore, the light values were only about one-third as great as in the earlier period. This introduces a complication, since with the greater light intensity the seedlings were doubtless able to add weight and to store food which might carry them for a considerable period after the light was reduced. However, an examination of the survivals at the ends of the two periods indicates that in both cases adjustment was made to approximately the same light intensity.

As to other conditions of the test, it should be said that watering was as uniform as possible, and it is believed that at all times the seedlings had abundant moisture, with little danger of excess, because of the free-draining character of the soil.

The temperature of the room averaged about 60 degrees F.³ during the entire period, with variations therefrom, according to season and hour, which can have little or no bearing on the results so far as can be seen. The temperatures were to some extent equalized by rotating the table three-fourths of a turn per day. However, it is evident that the light had considerable heating effect. Effort was made to dissipate this effect as far as possible by directing the draft from a fan on the center of the table, and this was doubtless effective in equalizing air temperature. But thermometers half imbedded in the surface soil showed excess temperatures of 14.5 degrees and 5 degrees, respectively, immediately beneath the 200-watt and 75-watt lamps. Similar thermometers 20 inches from the center showed excess temperatures of only 1.0 and 0.5 degrees. Since the edges of the table came nearest to radiators, they showed a very slight excess during the winter period.

To make a scale of light values corresponding to successive distances from the center of the table, the heating value of the 200-watt and 75-watt lamps were determined by measurements at 3-inch intervals, in every instance exposing a surface normal to the rays from the lamp. That these light values do not decrease as the square of the

³ This is not from the air temperature record, but represents the average of soil-surface temperatures at noon and 6 P. M., where least affected by the light.

distance from source increases, is, so far as the writer can determine, solely due to the fact that the source of the light is not a point, but a considerable area.

The total energy of the light at various distances was measured by means of a Coblentz linear thermopyle, air-mounted, and a L. & N. high-sensitivity galvanometer, by the direct deflection method, i. e., considering the scale readings to represent proportionate energy values. All such readings were compared with the greatest deflection obtainable in sunlight at midday, on two or three days near September 20, 1923, such maximum deflection being considered to represent unit light value for this experiment.

The actinic value of the light was similarly determined at 6 and 20 inches from the 200-watt lamp by exposing a "printing-out" photographic paper, enclosed in the Clements photometer, and comparing the shades so obtained with a scale of shades made in full sunlight. According to the best information obtainable from the Eastman Kodak Laboratories, this printing-out paper is most sensitive to rays in the region of 420 m μ . It is, therefore, not surprising to find, by this scale, that the actinic value of the light used is comparatively low, for, according to data supplied by Dr. Forsythe of the Nela Research Laboratories, both the 75-watt and 200-watt lamps, with blue glass, transmit practically nothing of wave length shorter than 460 m μ (blue) and each has comparatively high energy values in the region of 560 m μ (yellow-green) and in the red at 680 m μ .

This, so far as I can see, covers the essential conditions of the experiment, which was intended to be so simple in design as to tell its own story, by graphic methods, as I shall soon show you. Just a word, however, as to the observations on seedlings.

Within a month of the beginning of the test, seedlings around the edges of the table began to drop out, the collapse in most instances resembling that which results from the attack of damping-off fungi. This may be of interest to pathologists, for it can be stated that the sand used has been peculiarly free from these diseases, in thousands of germination tests in which the sand-boxes were freely insolated. The loamy soil we should expect to be richer in parasitic organisms, and as has been stated, the death of seedlings there, in the early stages, was rather more prompt and affected a greater number.

The observations were repeated at irregular intervals in the hope of recording the species and position of every seedling that died, but it

must be admitted that a small percentage escaped, or rather, wilted or dried so quickly that positive identification could not be made.

At the time of changing to the light of lower intensity, the positions and heights⁴ of all surviving seedlings were recorded.

At the end of the test the same data were recorded. Each seedling was then removed from the soil, with its entire root system, washed, weighed "green," oven-dried and again weighed. The heights and dry weights are of greatest interest.

RESULTS

Location of Survivors:

As has been stated, the essential results of this experiment were readily expressed graphically by plotting the position of each seedling, surviving or dead, according to its distance from the center of the table, and plotting a curve of light values similarly corresponding to distance from the source of light. The very simplicity of this relationship makes it unnecessary to reproduce the diagram. But it is worth noting that, for any species, there was only a comparatively narrow zone of overlapping for the surviving and dead seedlings, showing clearly that survival was very definitely limited by the light intensity, even with such factors as the damping-off fungi playing a part.

The important feature of the results, the minimum light intensities tolerated by the seedlings, are shown in the following table.

TABLE I
MINIMUM LIGHT REQUIREMENTS AS SHOWN BY SURVIVALS AT END OF
11-MONTH PERIOD

Species	Minimum Light Requirement	Light at Same Point First Half of Period	Burns' Figures
Percentages of full sunlight ⁵			
Douglas fir.....	0.77	2.06	7.6
Pinon	0.91	2.52	
White pine.....	0.97	2.75	5.8
Engelmann spruce.....	1.02	2.95	5.9
Bristlecone pine.....	1.20	3.54	
Western yellow pine.....	1.60	4.95	17.0
Lodgepole pine.....	1.90	5.80	7.6
Norway pine.....	2.30	7.02	

⁴ The heights here referred to are really lengths of stem to base of cotyledons, since, with the exception of pinon, there was very little stem growth above the cotyledons.

⁵ Referred to September 20 sun, at elevation 8,850 feet for present experiment; to December 22 sun, nearly sea-level, for Burns'. Correspondence with the U. S. Weather Bureau indicates a probable ratio of about 6:5 between these two standards.

It is seen that the most persistent seedlings, those of Douglas fir, were surviving in light of less than one one-hundred and twentieth of the intensity of sunlight, while the highest requirement was exacted by Norway pine, at 2.30 per cent. Even if we were to use the higher-scale values for light from the 200-watt lamp, whose influence, as has been stated, was practically nullified at the end of the test, the percentages are very much less than those determined by Burns. In fact, the only similarity of the two sets of data seems to be in ascribing co-ordinate positions to Engelmann spruce of the Rocky Mountains and to white pine of the East.

If we were to make an allowance of 20 per cent, or even of 33 per cent in Burns' figures, because of the fact that his sunlight standard was unquestionably of lower value, his percentages would still not be at all comparable with ours.

The explanation of the comparatively low light intensities tolerated is probably to be found in the fact that the quality and duration of the light supplied by the lamps in this experiment were particularly favorable. There is some reason for believing this to be the case, from the fact that the yellow pine grown close to the light, in this experiment, with intensities of 39 per cent and 13 per cent during the two halves of the period, was a far sturdier seedling than has ever, so far as known, been grown with normal sunlight, in the same type of soil. Most of the other species also produced some seedlings well above the standards for normal growth. But any distinction between the influences of quality and duration must remain in doubt until further experiments have tested the effects of each factor separately.

There are indeed some positions in this scale which tax the credulity, although we have much evidence for believing Douglas fir to be a very tolerant tree in its infancy, as shown by its extreme sensitiveness to heat. The position of pinon, a very hardy, heat-loving species, is perhaps most surprising. Its occurrence so low in the scale at once suggested that its persistence might be related to the large size of the seed and the sturdy character of the seedling, giving it a reserve of energy to draw upon long after photosynthesis had ceased. There is considerable evidence in support of this view, since, relative to seed weights, the dry weights of the poorer pinon seedlings were the lowest shown by any species. It is hardly fair, however, to compare the dry weight of the poorest individual with that of the average seed, since, especially with seeds so large as those of pinon, the individual variations in weight are very great. Therefore comparison is made with the

weights of the three seedlings of each species growing in the weakest light. It should be borne in mind, however, that 50 per cent of the whole seed weight is usually hull, and that while the remainder is essentially starchy food containing very little moisture, probably not more than half of this is ordinarily absorbed by the plant.

TABLE II

POSSIBLE INFLUENCE OF SEED WEIGHT ON ABILITY TO SURVIVE IN WEAK LIGHT
(Species Arranged in Order of Increasing Ratio of Seedling to Seed Weight.)

Species	Average Whole Seed Weight mgs.	Average Weight of Seedlings Farthest From Light mgs.
Pinon	306.9	96.3
Bristlecone pine.....	20.4	9.7
White pine	12.2	8.7
Douglas fir	9.5	7.0
Norway pine.....	7.2	6.0
Western yellow pine.....	39.5	37.3
Engelmann spruce.....	2.6	3.7
Lodgepole pine	3.2	5.3

The above table indicates that with all species except pinon some growth was probably made in the weakest light tolerated. If we were to accept as evidence of growth a seedling weight one-half as great as the seed weight, we should have pinon moved up in the scale to a point between yellow pine and lodgepole, or a light intensity of about 1.77 per cent, while the relative positions of the other species would not be changed. Nevertheless it is evident that there is wide divergence between the species in their ability to persist without making appreciable growth, which seems to be somewhat dependent on the initial masses of the seedlings. Had this phenomenon been observed under natural conditions we should say without much hesitation that the deep initial rooting made possible by the food obtained from the seed, was a considerable factor in survival, and might be considered one element in the so-called shade tolerance. But under the favorable moisture conditions of this experiment the value of deep rooting is not so apparent.

This whole question points strongly to the need for a repetition of the experiment with seedlings of the various species on a parity as to size, and with the green weight of each seedling determined at the beginning and end of the test.

Height:

In previous experiments in which variations in light supply have been obtained by shutting-off the light in one manner or another—this

resulting in more or less confinement of the plants, proportionate to the reduction in light—and in nature, evidence is frequently seen leading to the belief that lack of light stimulates height growth. This may be the case when the limited source of light is overhead, but a casual examination of the data is sufficient to show that in this experiment there was very little difference in stem length which can be traced to light intensity, even though these stems, at the period of their most active elongation, showed a very marked degree of phototropism.

Root Development:

As will readily be seen by reference to the photographs of selected seedlings surviving in the various light intensities, the comparative weakness of those receiving the least light is even more markedly shown by their poor root development than by their foliar development. There were no noticeable exceptions to this among all the seedlings taken up at the end of the test. It may, then, be said with considerable certainty that when food is not available the root suffers most. Consequently a seedling without sufficient light is subjected to much greater dangers from drought or lack of soil nutrients.

SUMMARY

1. Seedlings of eight species of conifers were grown under artificial light comparatively rich in the longer wave-lengths of the visible spectrum, and varying in intensity from 53.5 per cent to 1.2 per cent during the first six months, and from 16.6 to 0.4 per cent during the last five months of the exposure. Approximately the same adjustments to minimum light had been made at the end of each period, but no complete measurements were made except at the termination of the 11-month test.

2. At the end of the 11-month period, seedlings of Douglas fir were surviving in light of an intensity of 0.77 per cent of that of noon sunlight on September 20, and those of Norway pine in an intensity of 2.3 per cent. Pinon, white pine and Engelmann spruce required one per cent or less, while bristlecone, western yellow and lodgepole pines ranged from 1.20 to 1.90 per cent. Since there is a ratio of 3:1 between the most tolerant and least tolerant of the species here considered, it can hardly be questioned that there are important differences in the photosynthetic efficiency of trees as closely related as the members of the pine family.

3. The comparatively low values tolerated may be ascribed to the quality of the light available and to its comparatively long duration each

day. In any comparison of experimental with natural conditions, both duration and intensity should be taken into account.

4. Pinon and the other larger-seeded pines grew less vigorously than the small-seeded species in the weakest light in which each survived. The bearing which this may have on the major results is not clear. Only in the case of pinon is it evident that life was maintained at the expense of food absorbed from the seed, so that this species must be placed higher in the scale than its actual position indicates.

5. The height of seedlings surviving was not visibly affected by the light intensity, a fact which gives rise to the belief that when shading appears to stimulate height, it is because the only available light is overhead, and because the conditions which produce shade are also likely to decrease the transpiration demand.

6. The root lengths and branching were very markedly reduced in weak light, suggesting that seedlings may readily succumb to unfavorable soil conditions when the light intensity is great enough to permit some photosynthesis.

7. From this experiment we gain the impression that in the forest, light is not likely often to be the limiting factor in the survival of seedlings, since light intensities of less than two or three per cent are not often encountered. While most of our data for forest conditions have been obtained by photometric methods, which take no account of the lack of longer wave-lengths in the diffuse light which is sometimes the major supply of seedlings under the canopy, total-energy measurements recently made by the writer showed values of 10 per cent under canopies so dense that apparently all seedling growth has been inhibited for many years. Furthermore, there was scarcely an hour in the day when, at a given point of observation, some direct rays from the sun were not filtering through. It is, therefore, quite evident, that in most instances in which we might say that light in the forest is a limiting factor, it is not so in the absolute sense, but the variations in photosynthetic capacity between species give rise to long-term struggles for supremacy, in which rooting-vigor and domination of root-space, or ability to make good use of a small moisture supply, are almost certainly the determining characters. It is not irrelevant to mention that a study of the water-requirements of the same species⁶ led to essentially the same conclusion, namely that the struggle between species is a struggle dependent on the ability of the species to make growth with a minimum use of water, and that the relative photosynthetic capacities of the species are an important element in this struggle.

⁶ Bates, C. G. Physiological Requirements of Rocky Mountain Trees. *Journal Agr. Res.* 4-14-23.

COLLEGIATE FORESTRY EDUCATION

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Student opinion is a very important factor in the success or failure of university teaching. It can not be ignored, and every effort should be made to direct it into the proper channels. This discussion centers around the opinions on forestry education held by the present day college students, tempered by four years of intimate contact with the teaching profession.

The average freshman has not only a vague idea as to why he is going to college, but often a very much vaguer idea as to why he is taking the course that he is. Most men come to college either because it is the proper thing to do socially or because they hope to increase their earning capacity to the "nth" power. They do not like to admit it, but many of them have tucked away in their minds a life of comparative ease in high executive positions, abounding with personal importance, social activity, and travel. Now, higher education is generally considered a process by which man is made wiser, happier and more useful to himself and his fellowmen, but it need not necessarily increase one's earning power, one of the chief points of the students' conception. Of course, a higher education usually does have a distinct dollars and cents value, but not to the degree imagined by the freshmen.

The environment of our American colleges and universities does not disillusion the incoming student: to him college life seems a step in the right direction. It is true, that somewhere he may have heard that college graduates do not always end up at the top of the ladder of worldly success, but he casts this aside as an exception or a rumor and dreams on. If this dream is shattered early in his college career the disappointment will be short lived, as he can still readily make such alterations in his plans and mental concept as are necessary. The forestry student should be told frankly and emphatically just what his future prospects are, both as a college graduate and as a professional forester. When he is made to realize that service and not wealth is the usual attribute of the forester, he will either face the future as a forester with a clear understanding of his expectations, or he will change his course. Unfortunately, the intentional or unintentional optimism and enthusiasm of the professional forestry teacher toward his life work often tends to paint too rosy a picture.

The course that the freshman elects is not the result of an intelligent understanding of what he is primarily fitted for, but is largely a matter of chance. He usually has little or no opportunity to determine in which field his latent ability lies. He may feel that he should take mechanical engineering because he has tinkered with an automobile and enjoyed it, or he may have spent a jolly vacation in the woods, and hence, feels that forestry would appeal to him. However, more often he does not even give the matter serious consideration. He knows or has heard of a successful man in some field of endeavor whose life he would like to imitate, or he is persuaded to take a certain course on the representations of an acquaintance.

To partly overcome this inability of the freshman to come to a proper decision as to the course of study that he is best fitted to pursue, several institutions are now requiring all freshmen to take one or more orientation or survey courses designed primarily to acquaint the student with the various fields of study. Properly conducted orientation courses are very helpful, and their use should be extended. Of course, the effect of word pictures of any particular field of endeavor depends in part upon the interpretation and imagination of the student. Even short trips into the field or laboratory, while often of more value than mere lectures, may not furnish the true perspective.

This is especially true in forestry where the future environment of the worker is often totally different from the one to which he is accustomed. Executive ability, a willingness to work hard, and an inclination for the natural and mechanical sciences do not necessarily make a man a good forester. Many a would-be forester has found that his first joy in the companionship of nature and the rougher human element turns to dislike as time goes on. Such a man is obviously out of place in most forestry positions. Some schools now require that students spend at least one summer vacation in the woods doing some form of forestry work. One summer will usually suffice to show them whether they are in the proper niche. Every forest school should require such a summer of practical work which should not come later than the sophomore summer, as the student can change his plans more easily before he begins his upper class courses. Summer camps where all the members of one or more classes come together for laboratory practice can in no sense be considered as equivalent to a summer of practical field work. Such camps merely simulate conditions they will later find in the field.

Once in a while we find students who desire practical courses—the application of the theory. They want something concrete, something that they can apply immediately. Of course, these men overlook the fact that the application of any theory differs with each individual case, and that a college education is in reality nothing more than a process by which they are trained to think for themselves. Forest schools, in very wisely turning a deaf ear to such urging, often make no attempt to impart to them the reason for the lack of such courses. Such students easily lose interest in theoretical, so called “hot air” courses unless they can see their relation to the future.

Forest schools, although not usually giving trade courses as such, have at times sought to appease the students' and employers' demand for them by allowing overspecialization. The student feels that he ought to be allowed to spend much, or even most, of his time studying that branch of forestry in which he is, or thinks he is, especially interested. “Why should I study silviculture when I am going to follow logging engineering?” No one will criticise the forest schools for requiring all forestry students to take elementary courses in all branches of forestry, but many will criticise them for allowing them to take specialized courses as electives if they have time left.

Here the question arises, Is there time left for specialized courses in a four-year college curriculum? The student will immediately answer, yes, pointing to the “useless” courses he must take either as electives, or as required work. In some instances the student is doubtlessly right that certain courses that he must take might well be replaced by more valuable ones. This is especially true in some institutions where forestry is a department in a college of agriculture where the freshmen and sophomores must all take the same work. If these students transfer to some other forest school they will often find that some of their courses are not acceptable there toward graduation. Where such a situation exists, the remedy, while obvious, is often difficult to apply. Convince a college professor that his course is not the most important in the curriculum, and you have not only to overcome all of his enthusiasm and pride, but also, possibly his selfish interests.

Granting that no courses are required that are not of direct and lasting value to the professional forester, is there time for specialization? There is not. Foresters and employers of foresters must remember that there are other things in life besides earning one's bread and butter, and that the university class room and campus are the best places in the world to acquire such training. Education is not simply a

means to make men better technicists in some particular field of endeavor, but also should tend to make men broader. The maximum measure of happiness and usefulness to themselves and their fellowmen can not be secured by narrow specialists. Quoting Emerson: "Colleges can serve us only when their aim is not to drill but to create." Furthermore, not over 50 per cent of the students now taking professional forestry remain in the profession, and the schools owe it to these students to give them as broad a training as possible to fit them best for whatever will be their future life work. Specialization will not do that.

Students also have very decided opinions concerning required courses. Upon entering a university he can choose the college and the particular department in which he desires to study. In many cases having so chosen, he must follow a rigid course of study with little room for electives. This is based upon the theory that experienced teachers know what is best for the student. He may know, but unless he can make the student agree with him and willingly take the courses, his experience is worthless to the student. Coercive action against the student's judgment destroys interest. If the student has no interest in the subject of the course, he is not only wasting his time, but his presence in the class retards its progress and makes it very difficult to teach. "You can lead a horse to water but you cannot make him drink," is an old adage that fits here admirably.

The student has several specific criticisms in this connection. He feels that he should not be required to take preparatory courses in which he is not interested. The answer to this is, of course, that any candidate for the degree of Bachelor of Science must be adequately versed in the fundamental sciences upon which the degree is based. The difference of opinion here centers around the words "adequately prepared." A more liberal interpretation of this term is being demanded. One well known university now offers a Bachelor of Science degree for 45 hours of required work and 75 hours of electives. Even in this required work there is considerable choice as a student may, for instance, take six hours of elementary botany, biology, or zoology, six hours of chemistry or physics, and a total of 18 hours of any of the following subjects: botany, zoology, chemistry, geology, geography, mathematics and drawing. The only courses that must be taken without choice are six hours of English and six hours of political science. Such liberal requirements are to be highly commended.

A practice that is particularly distasteful to the student, and that is extremely poor pedagogy, is the attempt made in some schools to hold

a student to a specialized course even after he has lost interest therein. The only alternative that he has is to lose most of the credit for his specialized studies and begin over again. Thus, a student who has completed three years of a forestry course and finding that he is not fitted for the work, must often put in an extra year or more if he changes to some other course in the same college. Very often the desire to finish with his class and begin his life work will cause a student to continue sitting in on technical forestry courses even when he knows that he will never use the specific material that he is absorbing. In the institution previously referred to, all the professional forestry courses are included in the 75 hours of electives, and the student can at any time cease taking the forestry courses as recommended and still receive credit for all the work that he has completed.

Some educators will throw up their hands in horror at such student freedom. Again I quote Emerson, "Free should the scholar be." It should be remembered that the purpose of a four-year college education leading to the *academic* degree of Bachelor of Science is to turn out trained thinkers proficient in the sciences. It is not a professional or trade degree to signify a fitness for any particular line of work. Contrary to the belief of some educators, this liberal policy of degree requirements does not usually result in college graduates without a coordinated education. The student will usually follow the course of study recommended by his faculty advisor, making only such changes as he deems necessary after careful thought and discussion. Education is supposed to teach a man to think, but still many so-called teachers seem to think that they should do all the thinking for their students.

Perhaps more student criticism is leveled at the teacher and his method of teaching than at any other part of the educational system. As a matter of fact, most of the many criticisms that are constantly being hurled at our educational system have more than a grain of truth in them, because the system merely portrays the teacher around whom it is built. The system as a whole is manned by distinctly inferior individuals. The career of a teacher from the primary schools up, holds little to attract the best type of American. "If you cannot do anything else, teach." As a teacher your life can be one of comparative ease with little of the uncertainty and competition that adds zest to life in the business world. A teaching position once acquired is practically permanent so long as the incumbent behaves and applies himself with more or less diligence. Nothing uncertain or adventurous in such a life, just a sure means of making a fairly comfortable living. Little improve-

ment in our educational system can be expected until character and remuneration, and not scholarship and a willingness to labor for a pittance, are considered premier factors in choosing teachers.

There are of course many, many exceptions to the dismal picture presented in the last paragraph. Forestry teachers, especially, can take a small measure of comfort in the fact that the teaching profession has attracted many of the best foresters because the stipend of a forestry teacher has, until the last few years, been above that generally paid to foresters of similar ability in other fields. The tendency in the past has been to pick the most widely known foresters for teaching. Just now it seems to be to pick the most learned foresters. The emphasis in any form of collegiate education should be laid on educational methodology. Forestry educators, not foresters, should teach forestry in our under-graduate forest schools. "He knows his stuff but he can't put it across," is a very familiar student lament. I feel that at least half of the foresters engaged in teaching, while no doubt good foresters, are poor educators. A quotation from MacCaughey is peculiarly fitting here: "Many kindergarten teachers are really better and more efficient teachers than many college and university professors. Indeed, the notorious rarity of good teachers in colleges and universities tempts one to jump to the erroneous conclusion that the longer one 'goes to school' the less he is fitted for teaching." Other courses are laying more stress on pedagogy, and forest schools must do the same.

Now a word as to research. It seems to be the fashion just now for all foresters who have any opportunity at all to dabble in research. Many teachers of forestry have research projects listed. A list of the reasons why teachers of undergraduate forestry courses should not attempt to carry on research follows: (1) Most forestry teachers carry too much class room work to have time for research, if that teaching is properly performed. (2) The practice of pedagogics is not dead and dry as some assert. If investigations are necessary to keep up the teacher's interest, the fault lies with the teacher and his method of teaching. (3) In this age, a successful investigator must be highly specialized. A high degree of specialization is usually not compatible with a successful undergraduate teacher. (4) A forester is a jack-of-all-trades and his fundamental training usually precludes his being an investigator.

While this discussion has to do primarily with the undergraduate training of foresters, still much of it can be applied with profit to the graduate school as well. Graduate study should meet the student's de-

sire to specialize. The professor of a graduate school should differ markedly from the undergraduate teacher in that he should be a specialist and a thorough investigator. If the forestry profession jealously insists that such professors, leaders of scientific thought, must primarily be foresters, they should have a doctor's degree which would necessitate at least three years of intensive study in some one scientific field. Even then, I do not believe that they are as well equipped to lead student thought as the investigators trained for seven years in a particular field with, of course, enough forestry to give them the proper perspective.

In conclusion, allow me to recapitulate the points that this discussion has tried to bring out:

1. Student opinion and interest are important factors in successful pedagogy.
2. Orientation courses and summer field experience are tremendous aids to the student in finding himself.
3. Practical courses are not a proper part of a university education.
4. Specialization should not be included in the training of a candidate for the academic degree of Bachelor of Science.
5. The student should be given more freedom in choosing his courses and in changing from one department to another.
6. Undergraduate forestry training should be exceedingly broad, allowing plenty of time for electives in other fields of knowledge.
7. More electives will not lead to haphazard training.
8. Teaching, as a rule, does not attract the best type of individual.
9. Many foresters engaged in the teaching profession are poor educators.
10. Research, generally, is incompatible with undergraduate teaching.
11. The training of the present day forester is not best fitted for the research worker in forestry.

SILVICULTURAL NOTES ON THE BENGUET PINE

A. H. MUZZALL, M. S. F.

Introduction:

The Benguet pine (*Pinus insularis*) is found only in central and northern Luzon, P. I., in the mountain regions, at elevations of 4,000 to 9,000 feet. This region has a distinct dry season, also the heaviest rainfall of any place in the Islands. The annual rainfall at Baguio averages about 200 inches.

The topography is very rough, the country being broken up into many irregular ridges and peaks, both by folding and volcanic action. There are a few broad valleys and many steep slopes, with numerous small swift-running streams.

The soil is very variable. Some slopes have a deep, reddish clay loam of volcanic origin. On many slopes this type of soil is very shallow, being underlain with a basaltic type of rock. There are considerable areas of light grey friable clay loam, underlain with limestone.

The Benguet pine is a small tree compared to the pines of America; it ranges from 16 inches to 32 inches in diameter, and from 65 to 100 feet in height. The average mature tree is about 24 inches d. b. h. The needles occur three in a sheath—six to eight inches long. Cones are oval and measure about two by three inches, being very similar to those of the Loblolly pine of the southern states.

The tree is a very prolific seeder some years and produces light crops most every year. Germination takes from 12 to 20 days, about 67 per cent are successful.

The bark on trees of 24 to 32 inches d. b. h. is about three-fourths inches thick on an average. Occasionally bark two inches thick is found.

The wood is variable as to color and weight. The sapwood is yellowish white; the heartwood is light reddish brown. Some trees are very resinous, giving a dark reddish color. There is a great variation in the grain; many pleasing effects are obtained in the slash grain cuts. Curly and wavy surfaces are often cut, approaching the appearance of "bird's eye" maple.

Stands are very irregular; there are large areas where no trees grow, then there are scattering trees over large stretches with dense patches at intervals. Some of these patches will run 45 M. per acre, but the average stand where there are trees is less than 20 M. per acre. The following table shows the number of trees and volume in board feet per acre by diameter classes:

Diameter Class, Inches	Number of Trees per Acre	Board Feet per Acre
8	9	240
12	8	1,050
16	7	2,430
20	5	2,500
24	4	3,500
28	3	4,300
32	1.2	2,180
36	1	1,750
38	1	2,050
	<hr/> 39	<hr/> 20,000

Reproduction:

Reproduction will be considered under two headings: in virgin stands and in logged areas. In the virgin timber, the reproduction is very poor. In the dense stands there is very poor germination and only a few seedlings are noted. In the open areas the grass does not allow the seedlings to obtain a start even when the seeds do germinate, which is rare. Along the sides of dense patches and in small open places there is good reproduction. The poor reproduction in the open areas may be due to the periodic burning off of the hillsides by the natives who graze herds of cattle. On the steep rocky hillsides, the germination and growth is very poor.

In the logged off areas, the soil is stirred up considerably, exposing the mineral soil, thus affording good germination and growing conditions. Dense young stands are noted all over the logged areas, forming good protection to the water sheds, besides assuring a good future supply of timber.

The rate of growth on the best sites is very good up to about 12 inches d. b. h. From 12 to 16 inches it slows up to about 50 per cent and from 16 inches up it is about 100 per cent slower. The following table gives an idea of the growth under average conditions:

RIDGE TYPE		
D. B. H. in Inches	Height in Feet	Age in Years
2	14	6.0
4	20	11.2
8	25	20.3
12	43	46.0
16	49	66.1
20	56	85.4
24	60	102.5
28	64	120.0
32	68	140.0

(This table is from the Bureau of Forestry Records, "Working Plan for the Baguio Forests," by M. O. Otayza, 1919.)

The bottomland type produces a much faster rate of growth, trees 32 years of age attaining a diameter breast high of 12 inches under medium conditions of density.

Where this tree has been planted in the lowlands in the Philippines it has shown a faster growth. Seedlings at Los Banos three years old averaged 10 to 15 feet in height. In South Africa, where considerable plantings have been made, an average height of 15 feet was attained in five years.

It has been noticed in the plantings made in the lowlands of the Philippines that good growth was not made unless some of the soil from the tree's native habitat was brought along with the seedlings. The reason for this has not yet been determined.

The method of cutting is a modification of the clear cut system. Seed trees are left at intervals, assuring good distribution of seeds. The marking has been well done, as the resulting stands of reproduction show.

• *Conclusions:*

The results of this brief study show that the cutting of the stands of mature timber in this region not only causes a more uniform distribution of the future stand of timber, but also promotes a denser cover on the mountain slopes, thus affording a better protection to the watershed than is found on the uncut areas, where there is practically no ground cover or reproduction.

With proper management, a good stand of merchantable timber should be produced in 80 years after cutting. The dense stands of reproduction will also afford a continual supply of fire wood from periodic thinnings. To insure a good uniform stand of timber for the future it is necessary that fires be kept out, as continual burning destroys the reproduction and helps the grass to gain such a foothold that germination becomes practically impossible.

A PROPOSED CLASSIFICATION OF THE FOREST TYPES OF THE LAKE STATES

COMPILED BY JOSEPH KITTREDGE, JR.

Lake States Forest Experiment Station

During the winter of 1923-1924, the subject of a classification of forest types for the Lake States was taken up for discussion in a series of seminar meetings at the Forest School of the University of Minnesota, at which members of the Lake States Forest Experiment Station and of the Botany Department of the University also took part. While a definite classification did not result directly from these meetings, it has seemed worth while to attempt to supplement and crystallize these discussions into a classification of forest types for the region which may be adopted for general use by foresters and others having occasion to distinguish the different forest conditions. Accordingly, after the close of the seminar meetings, a tentative draft of the classification was drawn up and copies submitted to the Minnesota, Wisconsin and Ohio Valley Sections of the Society of American Foresters for comments and suggestions. Many valuable suggestions were received, and the following classification has resulted.

In compiling the classification the attempt was made to distinguish and name the types on the basis of the species most characteristic in each as the most obvious and logical distinction between types. For each type, brief notes have been added on the composition, the sites where the type occurs, the range within the region, and the developmental relations including both the natural succession and the changes as a result of clear cutting and fire. Inevitably, the classification or any classification will not cover all the modifications and transitions of type which will be found frequently and which are inherent in the complex biological forest communities.

The classification of types which has been adopted by the New England Section of the Society was considered in the preparation of this classification. Although many of the types are similar in the two regions, there are many differences and the New England classification did not seem to fit conditions closely enough in the Lake States to justify attempting to mold it to fit a different region.

There is a part of the region, chiefly in southern Michigan, which is more closely related to the forest conditions of the Ohio Valley to the south than to the larger portion of the Lake States to the north. It is understood that the Ohio Valley Section of the Society is considering

the preparation of a type classification for their region. It will undoubtedly distinguish types which are found in southern Michigan but which have been mentioned only as variations of broader types in this classification. Eventually, the National Society will very possibly undertake the compilation of a forest type classification for the United States or North America. Regional classifications will then have to be fitted together. As a basis for this larger undertaking, it is desirable that slightly different proposals may have been made in different regions so that their advantages and disadvantages may be weighed and thereby contribute to a better country-wide classification.

TYPES RECOGNIZED

- | | |
|-----------------------------|--------------------------|
| 1. Northern white cedar. | 10. Jack pine. |
| 2. Tamarack. | 11. Jack pine—oak. |
| 3. Black spruce. | 12. Aspen—(paper) birch. |
| 4. Black ash—red maple—elm. | 13. Maple—hemlock. |
| 5. Silver maple—elm. | 14. Maple—basswood. |
| 6. Cottonwood—willow. | 15. Oak—maple. |
| 7. Spruce—balsam—birch. | 16. Oak—hickory. |
| 8. White pine. | 17. Burr oak. |
| 9. Red pine. | |

TYPE DESCRIPTIONS

1. *Northern white cedar*

Composition: Northern white cedar, pure or predominating in mixture with balsam fir, birch, tamarack, spruce, black ash, red maple, or white pine.

Site: Swamps with good or at least partial drainage, not acid, or on upland limestone sites.

Range: Northern halves of the three states.

Developmental relations: After fire or cutting, is replaced by alder, black ash, elm, red maple and balsam fir. Undisturbed, it maintains itself.

2. *Tamarack*

Composition: Tamarack, pure or predominating in mixture with black spruce and rarely with some cedar.

Site: Swamps with little or no drainage.

Range: Throughout Michigan, Wisconsin and northern Minnesota. Pure tamarack swamps occur south of the range of black spruce in the southern part of the region.

Developmental relations: After cuttings, fire or other accident, replaces itself. Succeeded by spruce on wet acid sites, or by balsam fir and cedar on better drained alkaline sites.

3. *Black spruce*

Composition: Black spruce, pure or mixed with a little tamarack.

Site: Acid, undrained swamps or muskegs.

Range: Central Michigan, Wisconsin and Minnesota, northward.

Developmental relations: Replaces itself after cutting or fire often with tamarack in mixture. Permanent if undisturbed.

4. *Black ash—red maple—elm*

Composition: Black ash, red maple and elm in different proportions, predominating, sometimes with admixture of balsam poplar, swamp white and burr oak or white pine.

Site: Low, wet grounds, flooded part of the year.

Range: Throughout the region.

Developmental relations: Replaces itself after cutting. Undisturbed, cedar may come in.

5. *Silver maple—elm*

Composition: Silver maple and elm in mixture with river birch and white ash, and sometimes with small proportions of willow or cottonwood, or in southern Michigan with beech and sycamore.

Site: Silty soils of river bottoms and flood plains.

Range: Southern parts of the three states, extending north along the larger streams.

Developmental relations: After cutting and fires, replaced by willow and cottonwood. Undisturbed, it succeeds itself.

6. *Cottonwood—willow*

Composition: Cottonwood and willow, pure or mixed predominating, sometimes with river birch, white ash, elm or silver maple.

Site: Sandy, gravelly or silty soils of river bars and flood plains.

Range: Chiefly along the larger streams in Wisconsin and Minnesota.

Developmental relations: The pioneer forest growth on these sites. Replaces itself, after clear cutting. Followed by silver maple, river birch, white ash, or elm, if left undisturbed.

7. *Spruce—balsam—birch.*

Composition: Mixtures of white spruce, balsam fir and paper birch with jack pine, aspen and black spruce, in which any one or none of these species may predominate; sometimes cedar, red or white pine and maple also occur in the mixture.

Site: Well drained upland loamy soils.

Range: Northeastern Minnesota and extreme northern Michigan.

Developmental relations: Replaced by aspen-birch or jack pine after cutting or fire. Maintains itself if undisturbed with progressive increase in the proportion of white spruce.

8. *White pine*

Composition: White pine, pure or predominating, in mixture with red pine or sugar maple, birch, beech, basswood and hemlock. Pure stands of white pine now occur only as second-growth.

Site: Fresh, well drained soils, usually loamy.

Range: As a type, chiefly in the central part of Michigan, Wisconsin and in east central Minnesota, northward.

Developmental relations: After clear cutting and fire, replaced by aspen-birch; if unburned, by itself and hardwoods. If undisturbed, gradually replaced by sugar maple, beech and hemlock or spruce, balsam and birch.

9. *Red pine*

Composition: Red pine, pure or predominating in mixture with white or jack pines or red maple, and in young stands with aspen and birch.

Site: Sandy, or sandy loam soils.

Range: Central Michigan, Wisconsin and Minnesota, northward.

Developmental relations: After cutting and fire, replaced by itself, jack pine or aspen-birch. If undisturbed, it is gradually replaced by white pine, balsam and maple.

10. *Jack pine*

Composition: Jack pine, pure or predominating in mixture with red pine or scarlet and jack oaks, or with aspen, paper birch and black spruce.

Site: Typically on the driest, sandiest soils, usually originating from glacial outwash; also occurs on low, moist sands near swamps.

Range: Central Michigan, Wisconsin and east central Minnesota northward.

Developmental relations: Replaces itself or follows scarlet or jack oak after fire. Is replaced by red pine, scarlet or jack oak under natural conditions, or in the northeastern part of Minnesota by spruce-balsam-birch.

11. *Jack pine—oak*

Composition: Jack pine and scarlet, jack, black, white or red oak in varying proportions.

Site: Dry, sandy soils often on gravelly hills or moraines.

Range: As a type, chiefly in central Michigan and central Wisconsin.

Developmental relations: After fires, replaces itself. If interim between fires is too short for jack pine to produce a seed crop, it is eliminated. If undisturbed, will be succeeded by the associated oaks; without fires, the oaks will also take over the area.

12. *Aspen—paper birch*

Composition: Aspen, either *Populus tremuloides* or *Populus grandidentata* or both, pure or in mixture with varying proportions of paper birch which may sometimes predominate over small areas.

Site: This type follows fires on all soils excepting the poorest sands and the wet swamps.

Range: Minnesota, Wisconsin and Michigan; most common in the northern parts.

Developmental relations: Maintains itself after fires. If undisturbed, white pine, balsam fir, spruce or sugar maple, beech or hemlock gradually overtake and replace the aspen and birch.

13. *Maple—hemlock or hemlock—hardwood*

Composition: Hemlock, sugar maple, yellow birch, basswood, and beech in varying proportions predominating, with elm and small admixtures of white pine, red oak, white ash, balsam fir, paper birch, black cherry or spruces. A variation in which only beech and sugar maple are found is common in central and southern Michigan and in southeastern Wisconsin.

Site: Fresh, well drained, upland, loamy soils and sometimes also on sandy soils where there is a surface accumulation of organic matter.

Range: Beech does not occur further west than eastern Wisconsin where the limestone formation stops. Otherwise the type is found throughout central and northern Michigan and across the northern half of Wisconsin.

Developmental relations: Reverts to aspen—birch, following heavy fires. A permanent type if undisturbed.

14. *Maple—basswood*

Composition: Sugar maple and basswood predominating with admixtures of elm, white ash and occasionally oak and hickory toward the southern edge of the range of the type.

Site: Upland loamy soils.

Range: Found chiefly toward the western edge of the region in Minnesota.

Developmental relations: After fires, followed by aspen, birch or oak. A permanent type if undisturbed.

15. *Oak—maple*

Composition: White, red and burr oak with sugar and red maples in varying proportions, with smaller admixtures of elm, basswood and white ash.

Site: Good, loamy soils, well drained.

Range: Occurs chiefly in the southern part of the region forming a transition between northern and central hardwood regions.

Developmental relations: Reverts to aspens, inferior oaks, red maple, and hornbeam following fires. Maintains itself or tends toward maple—hemlock, or maple—basswood type if undisturbed.

16. *Oak—hickory*

Composition: White, red, black, scarlet, and burr oak, hickory and white ash with occasional small proportions of black cherry, butternut, and largetooth aspen. A frequent variation includes also elm, basswood, walnut, sugar maple and yellow poplar.

Site: Loamy soils.

Range: Occurs in the southern part of the region.

Development relations: Fires or overgrazing cause deterioration with more aspens, burr and scarlet oaks and hornbeams. If undisturbed, it tends toward the oak—maple type.

17. *Burr oak*

Composition: Burr oak predominating in mixture with red, white, black, scarlet, jack oak, basswood, and elm.

Site: Dry, loamy soils on the western edge of the region.

Range: As a type, chiefly in central and western Minnesota.

Developmental relations: Replaces itself after accidents. Tends to be replaced gradually by red and black oak, hickory, maple and basswood if undisturbed.

FREE DISTRIBUTION OF FOREST TREES IN PENNSYLVANIA

BY JOHN W. KELLER

Chief, Bureau of Extension, Pennsylvania Department of Forests and Waters

The Pennsylvania Legislature in 1915 passed an act authorizing the Department of Forests and Waters to distribute to private land owners trees from the State Nurseries, not needed for planting on the State Forests. These trees are to be given away under such regulations as the Department may deem best, but the applicant must pay the packing and transportation charges. This Act was passed to encourage private land owners to plant forest trees, and is uniformly endorsed by the people of Pennsylvania.

To date, the Department has distributed under the law, 40,707,448 trees to private land owners in Pennsylvania. It is very essential that frequent checks be made on the plantations that have been established to determine the results that private land owners are getting. The Department can then make distribution under regulations that will carry out the intent of the Act and protect the land owner by advising him in advance of the proper care and protection necessary to bring about a successful plantation.

SCOPE OF THE STUDY

Trees are furnished for timber production and windbreaks, but they will not be supplied for ornamentation and shade. The minimum number that is distributed to one applicant is 100 of any one kind of trees. It is not believed that the furnishing of less than this number falls within the intent of the distribution act. The maximum number to one applicant is 100,000 trees. This is an arbitrary number which is determined in an effort to have the available supply distributed to as large a number of planters as is possible. During the past 9 years 19 kinds of trees have been distributed for experimental and commercial plantings. They have been set out in every one of the 67 counties in the state.

After thorough consideration, it was decided that in a study of private tree plantings the plantations to be reported upon should be selected from the records of the Department of Forests and Waters, and not by the field representatives who are acquainted with the plantations. Therefore, a number of questionnaires were sent to the Dis-

tract Foresters, with the request that they make a careful examination of the plantings listed. The plantations selected were located in all parts of the state, but preference was given to those nearest the District Foresters' headquarters.

The trees for the plantings were distributed from the State Nurseries from 1915 to 1922, inclusive, it being considered best not to include trees distributed during 1923 and 1924, since errors might creep into the reports because of their small size. From 100 to 100,000 trees of all kinds distributed were included in the plantations examined. A copy of the questionnaire follows:

REPORT OF PRIVATE FOREST TREE PLANTING

TREES SUPPLIED BY THE PENNSYLVANIA DEPARTMENT OF FORESTS AND WATERS

Name of planter.....	Post office.....	
Trees planted in.....	County	Township
Kind of trees.....	Number.....	
Year planted.....	Spring or Fall.....	Age when planted.....
Acres.....	Spacing.....ft. x	ft.....
Kind of soil (sand, shale, clay, etc.).....		
Fertility of the soil (good, medium, poor).....		
Moisture (moist but well drained, medium, dry).....		
Exposure (north, south, east, west).....		
Slope (hill-top, steep, rolling, level).....		
Growth on ground when planted (grass, briars, trees).....		
Have trees been injured by fire?..... Stock?..... Insects?.....		
Natural growth?..... Other agencies?.....		
If so, what remedial measures have been taken?.....		
.....		
What per cent of the planted trees are now living?.....		
What is the present average height of the trees?.....		
Is the general condition of the plantation satisfactory?.....		
General remarks.....		
.....		
Name of Inspector.....		
Forest District.....		
Date of Inspection....., 19.....		

This report is based upon the examination of 214 plantings made by 95 planters. A planting is considered as all trees of one species planted in one year. A mixed plantation of white pine and Norway spruce would therefore be considered as two plantings. Ninety-four per cent of the plantings consisted of less than 10,000 trees. The success of species is considered instead of the success of plantations, because the selection of site is an important factor not included in this study.

RESULTS

The number of plantings, the number of trees planted, the number of trees living and percentage living, by species, is given in the following table:

Species	Number of Plantings	Trees Planted	Trees Living	Percentage Living
White pine.....	67	336,920	263,361	78%
Pitch pine.....	17	71,800	64,066	89%
Red pine.....	23	42,250	34,267	81%
Scotch pine.....	18	70,670	57,559	81%
Norway spruce.....	38	74,950	57,371	77%
Banks pine.....	9	44,500	39,175	88%
W. yellow pine.....	2	200	80	40%
European larch.....	14	103,000	54,595	53%
Japanese larch.....	2	800	720	90%
Arbor vitae.....	1	500	50	10%
Douglas fir.....	1	500	375	75%
White ash.....	5	5,600	5,080	90%
Honey locust.....	5	6,900	4,660	68%
Sugar maple.....	4	9,700	5,200	54%
Wild black cherry.....	2	700	610	87%
Red oak.....	2	1,600	1,110	70%
White oak.....	1	500	250	50%
American elm.....	1	1,000	600	60%
Black walnut.....	2	300	250	83%
Totals.....	214	772,390	589,379	76%

This table shows that 76 per cent of the planted trees are growing and indicates that hard pines, such as pitch, red, Scotch and Banks pine, are the conifers that can be most easily transplanted.

TOTAL LOSSES

Eighteen plantings were totally destroyed by fire, erosion and grazing. These trees are not included in the calculations quoted on the preceding page.

	Fire	Erosion	Grazing	Total
Number of plantations.....	10	3	5	18
Number of trees planted.....	27,100	2,200	2,850	32,150

These figures indicate that a planter runs one chance in 21 of having his trees destroyed by fire.

Erosion and grazing are not usually considered hazards. However, one-third of one per cent of these planted trees were destroyed

by erosion and two-fifths of one per cent by grazing. If proper care is given, trees should not be destroyed by these agencies.

MINOR LOSSES

Animals and insects have attacked numerous plantings and are doing serious damage at some places. Weather conditions, such as winter-killing, hail and drought, have done serious damage to a limited extent. These trees are included in the calculations given on the preceding page.

	Character of Injury							
	White Pine Weevil	Ants	LaConte Sawfly	Rabbits and Mice	Winter Killing	Hail	Drought	Man (By theft & trespass)
Number of Plantings Affected.....	35	2	7	2	7	2	6	2
Number of trees planted.....	232,420	6,000	57,400	3,500	2,600	700	95,800	2,800
Percentage living.....	75%	83%	85%	79%	13%	64%	54%	72%

The white pine weevil is the most common insect attacking planted trees. More than 50 per cent of the plantings have suffered. Thirty-two plantings not attacked show a survival of 85 per cent, and 35 plantings that have been attacked by it show a survival of 75 per cent. Therefore, it may be assumed that the weevil is doing damage that results in the loss of 10 per cent of the trees that are planted. It is readily seen that the weevil is proving a serious menace to planted white pine in Pennsylvania.

FERTILITY OF PLANTING SITES

The soils in which the trees are planted are recorded as poor, medium and good. Dry, sterile side hills are commonly classed as poor sites, gently rolling lands with thin soils compose a large part of the medium sites and fairly deep soils with a normal percentage of fertility and moisture are classed as good sites.

	Fertility of Soil			
	Poor	Medium	Good	Totals
Number of plantings.....	97	11	106	214
Number of trees planted.....	305,090	142,200	325,100	772,390
Percentage living.....	75%	76%	77%	76%

These figures confirm the general opinion that the best growth, regardless of the kind of trees planted, may be expected on the better soils.

MOISTURE OF PLANTING SITES

The height and density of growth on and immediately surrounding the planting site is the largest single factor in determining the moisture on the planted areas.

	Amount of Moisture in Soil			
	Dry	Medium	Moist but well drained	Totals
Number of plantings.....	60	60	94	214
Number of trees planted.....	136,650	373,750	261,990	772,390
Percentage living.....	72%	75%	81%	76%

As would be expected the amount of moisture has much to do with the success of planted trees. The best establishment has been on moist but well drained soils.

EXPOSURE

A comparison of exposures includes the plantings on slopes but does not include areas of level or gently rolling character.

	Aspect of Planted Area				
	North	South	East	West	Totals
Number of plantings...	32	39	33	31	138
Number of trees planted	39,400	47,450	137,300	42,100	266,250
Percentage living.....	78%	68%	67%	80%	71%

These figures indicate that a higher percentage of establishment may be expected on north and west exposures than on east and south exposures. The trees appear to be more easily established on the level and gently rolling sites than on the steep slopes.

SPACING

Ninety-eight per cent of the trees spaced four feet by four feet were planted prior to 1920, which shows that a wider spacing is coming into practice.

The results show that about 1,750 trees have been planted on the average acre. Since 76 per cent of the trees are growing there are remaining about 1,330 trees on each acre, which is a sufficient number to completely stock the areas.

CONTROL MEASURES

Remedial measures for the suppression of insect and fungi were resorted to by 15 persons who had planted 97,400 trees. These control measures consisted of picking off and destroying white pine weevil, cutting and burning weevil-infested white pine terminals, spraying to check ravages of the La Conte Sawfly, posting trespass notices where trees were being injured by man and cutting natural growing weed trees where they were retarding the growth of planted trees.

USE OF TREES

A few unfounded reports reach the Harrisburg office to the effect that trees supplied from the State Nurseries are being used for lawn plantings, contrary to the regulations governing distribution.

	Character of Use				
	Forest Planting	Reinforcing Existing Plantations	Wind-breaks	Orna-mental	Nursery
Number of plantings...	205	1	3	0	5
Trees planted.....	766,590	2,000	800	0	3,000
Percentage of the whole.	99%	.3	.1	0	.4

When the planting site is covered with heavy sod, briars and weeds, some owners prefer to plant the trees in a transplant nursery until they are large enough to compete successfully with the weed growth. Four-tenths of one per cent of the trees supplied from the State Nurseries were used for this purpose and later were transferred to idle lands.

The fact appears to be satisfactorily established that the trees are being used according to the regulations which require the planters to set them out for reforestation and windbreaks.

AGES OF THE TREES

The ages of trees, number planted and the number and percentages living are listed in the following table:

Species	Age	Number Planted	Number Living	Percentage Living
White pine.....	2	127,720	107,038	84
White pine.....	3	205,750	153,459	75
White pine.....	4	850	665	78
White pine.....	2-1	1,500	1,350	90
White pine.....	3-1	1,000	800	80
White pine.....	3-2	100	50	50
Totals.....		336,720	263,362	78

(Continued on next page)

Species	Age	Number Planted	Number Living	Percentage Living
Scotch pine.....	2	67,170	54,329	81
Scotch pine.....	3	3,500	3,230	92
Totals.....		70,670	57,559	81
Banks pine.....	2	7,500	6,525	87
Banks pine.....	3	37,000	32,650	88
Totals.....		44,500	39,175	88
Pitch pine.....	2	63,800	57,926	91
Pitch pine.....	3	1,000	840	84
Pitch pine.....	4	7,000	5,300	76
Totals.....		71,800	64,066	89
Red pine.....	2	4,450	3,023	68
Red pine.....	3	37,800	31,244	82
Totals.....		42,250	34,267	81
W. yellow pine.....	3	100	70	70
W. yellow pine.....	4	100	10	10
Totals.....		200	80	40
Norway spruce.....	2	500	300	60
Norway spruce.....	3	38,000	32,335	85
Norway spruce.....	4	34,300	23,785	69
Norway spruce.....	2-1	1,800	855	48
Norway spruce.....	3-1	100	60	60
Norway spruce.....	3-2	50	36	72
Totals.....		74,950	57,371	77
Arbor vitae.....	3	500	50	10
Japanese larch.....	2	800	720	90
European larch.....	2	68,300	33,792	49
European larch.....	3	34,700	20,800	60
Totals.....		103,000	54,595	53
White ash.....	1	2,000	1,680	84
White ash.....	2-1	3,600	3,400	94
Totals.....		5,600	5,080	90
Honey locust.....	1	6,900	4,660	68
W. black cherry.....	1	700	610	87
Sugar maple.....	1	5,000	1,250	25
Sugar maple.....	2	2,200	1,650	75
Sugar maple.....	1-1	500	400	80
Sugar maple.....	2-1	2,000	1,900	95
Totals.....		9,700	5,200	54
Red oak.....	1	100	60	60
Red oak.....	2	1,500	1,050	70
Totals.....		1,600	1,110	70
White oak.....	2	500	250	50
American elm.....	1	1,000	600	60
Black walnut.....	1	300	250	83

The results from this table may be used to support recommendations for the planting of trees of various ages. In advancing such theories it must be kept in mind that trees grown under irrigation and with fertilization and planting technique that 20 years of experience have developed are much larger than could be grown when the work was in its infancy. Trees grown in different nurseries and sometimes at different parts of the same nursery differ in size. In view of these variations it is difficult to arrive at definite conclusions concerning the ages that should be planted.

The Pennsylvania Department of Forests and Waters is favorably inclined towards planting the smallest trees for reforestation that will give satisfactory results. This should result in the establishment of sufficient trees per acre and the planting costs will be kept to the minimum. For this reason transplants are grown only in small numbers and these are used for planting on difficult planting sites that are covered with heavy sod or dense weed growth. Because of the psychological effect on inexperienced planters an effort is made to supply no trees that are less than five inches in height as they stand in the nursery beds. Trees of the following ages will usually be of this height, and are the ages most frequently supplied from the nurseries.

White pine.....2 or 3 yrs.	Norway spruce....3 yrs.	W. black cherry....1 yr.
Scotch pine.....2 yrs.	Arbor vitae.....3 yrs.	Sugar maple....1 or 2 yrs.
Banks pine.....2 yrs.	Jap. larch.....2 yrs.	Red oak.....1 or 2 yrs.
Pitch pine.....2 yrs.	Eup. larch.....2 yrs.	White oak.....1 or 2 yrs.
Red pine.....2 or 3 yrs.	White ash.....1 yr.	American elm.....1 yr.
W. yellow pine.2 or 3 yrs.	Honey locust.....1 yr.	Black walnut.....1 yr.

The figures given in this study may be interpreted in various ways but the intention of this article is to establish planting facts that will assist in the distribution of trees from State Nurseries and let private planters know what results of establishment they may expect and where they should get them.

The regulations governing the distribution of trees are subject to change in order that the trees will be used according to the intent of the distribution act, that the rights of shade and ornamental tree nursery-men will be protected and that idle forest lands within the Commonwealth will be brought back to production as rapidly as possible.

Summary of Conclusions

The conclusions reached from the study described in this paper may be listed as follows:

1st. Seventy-six per cent of the trees have been successfully transplanted. In planting on average sites in Pennsylvania, land owners may expect this percentage of trees to grow.

2nd. Hard pines, such as pitch pine, red pine, Scotch pine and Banks pine, may be successfully transplanted more easily than spruce, larch or other conifers. White ash, wild black cherry and black walnut are most easily planted of the hardwoods.

3rd. It may be assumed that fire has destroyed an average of $3\frac{1}{2}$ per cent of the trees planted. A planter has one chance out of 21 that his plantation will be destroyed by fire.

4th. The white pine weevil kills approximately 10 per cent of the white pine trees that are planted. Winter killing, hail, drought and trespassing by man may be expected to do some injury, but indications are that they will not affect noticeably the success of the planting.

5th. The best establishment, regardless of the kind of trees planted, may be expected on moist, well drained soils. This supports the general belief that thin dry soils as well as swampy areas will grow trees but it is more difficult to get them established than on better soils.

6th. A higher percentage of establishment may be expected on northern and western exposures than on southern and eastern exposures.

7th. A plantation may be considered successful even though but 76 per cent of the trees survive the transplanting. When spaced five by five feet apart (1,750 trees per acre), which is the average spacing used on plantings inspected, 1,330 trees will remain. This is a sufficient number of trees to fully stock an acre of land.

8th. Trees distributed from Pennsylvania State Nurseries are being used for reforestation and windbreaks as intended by law.

GRAZING IN PINE PLANTATIONS

COMMENTS BY C. L. FORSLING,

Ogden, Utah

The article "Grazing of Cattle and Horses in Pine Plantations," by Stickel and Hawley, in the December Journal, as well as the comments in the March number by Prof. Cope and the reply by the authors in a more recent issue, should be of immense interest to foresters. According to these two authors, grazing by cattle and horses in the pine plantations studied, caused no serious injury to the young pine, reduced the fire hazard, and reduced the competition of other vegetation with the pine production. To these doubtless may have been added the gains from revenue which the grazing brought in during the non-productive period of the timber. Prof. Cope doubts the findings because they are contrary to "accepted concept" of grazing in relation to reproduction and because, in his opinion, the conditions of the experiment were not satisfactory.

Granting that the results of the study in New England pine plantations establish a new order of things for the Eastern United States, what is the basis for the so-called accepted concept? They apparently are, (1) European ideas on the matter and (2) that many instances have been observed where no reproduction was coming in on pastured lands. At least, there is no record of a careful study of the problem having been made until this one by Stickel and Hawley. Surely there is no justification for turning down the results of a careful study in preference to an impression based upon foreign conditions or unsystematic observations as Prof. Cope would have us do.

We are coming to realize more and more that European practices can not be applied directly in this country and that methods based upon careful study of local conditions is the only correct basis. Doubtless, grazing in relation to reproduction falls in this category. Moreover it has been found that properly managed grazing under many conditions is beneficial rather than harmful in the forests of the West, although there are other conditions where grazing, especially of sheep, is injurious. Both grazing men and silviculturists attest to this. Sparhawk,¹ a silviculturist, was the first to make a study on western yellow pine lands in Idaho and found that carefully conducted grazing

¹Sparhawk, W. N. "Effect of Grazing Upon Western Yellow Pine Reproduction in Central Idaho," U. S. Dept. of Agriculture, Bulletin 738, 1918.

caused no injury to reproduction after the seedlings were a year old and that the benefits "may often offset the slight damage done by regulated grazing." Hill² and Sampson,³ both grazing men, made the studies which determined that sheep grazing under certain conditions were injurious to western yellow pine in Arizona and to aspen. Cattle as a rule are less browsers and less injurious to reproduction than sheep. Is it not plausible that there are conditions in New England and possibly elsewhere in the East where cattle may be grazed to advantage?

Prof. Cope questions the conclusiveness of the study "unless (the cattle are) present in sufficient numbers to close-crop the area in the sole effort of securing sufficient food supply." In other words, in his opinion, the area was not grazed heavily enough. Basing conclusions upon *overgrazing* rather than upon *properly regulated grazing* is a common error made in considering the relationship of grazing to reproduction. The authors stress *regulated grazing* in their article and it is doubtless under such conditions that they expect their results to apply. Over-grazing is undesirable from every standpoint and just as much so from the standpoint of forage production as from any other. Very often it is overgrazing and poor handling of stock that are responsible for the damage rather than just grazing. It has been found under Western conditions that so long as there is ample supply of forage plants that are more palatable to the grazing animals than the seedlings and the livestock are handled carefully, damage is negligible. There is no more justification for outlawing all grazing because some grazing is bad than there is to outlaw all logging methods because some methods are bad.

The value of regulated grazing in reducing the fire hazard is no longer in doubt in the minds of those who have had experience with fire and grazing on forest lands in the West. This has been fully discussed by Hatton.⁴ Nor is complete removal of all the herbaceous vegetation on the ground, such as may be had by very close grazing, necessary to reduce the fire hazard. Experience in the West has shown that proper utilization, i. e., utilization only to a point that will not reduce the productivity of the forage, is a very important factor in

²Hill, R. R. "Effects of Grazing Upon Western Yellow Pine Reproduction in the National Forests of Arizona and New Mexico," U. S. Dept. of Agri., Bul. 580, 1917.

³Sampson, A. W. "Effects of Grazing Upon Aspen Reproduction," U. S. Dept. of Agri., Bul. 741, 1919.

⁴Hatton, John H. "Livestock Grazing as a Factor in Fire Protection on the National Forests," U. S. Dept. of Agriculture.

reducing the damage of spread of fire and makes suppression easier. There is little doubt but what the fire hazard was reduced on plantations, where—"instead of the grass being shoe high or taller the ground cover has the appearance of a well cropped pasture" as described in the article by Stickel and Hawley. Such cheap protection for only 10 or 12 years if obtained without injury to the reproduction should certainly be well worth while.

This whole matter of the relation of grazing to timber production in the eastern half of the United States is one worthy of much more careful study and consideration than has been given it in the past. A lot of the success of getting land owners, especially those with holdings of the woodlot size, to grow wood is going to depend on how well grazing and raising timber can be harmonized, and much depends upon what happens on lands of that character. It is going to be much harder to put forestry across with an owner of such lands if it means that he must part with a few cows that bring in an annual return, however small, to produce a crop that will not yield an income for a number of years, regardless of how much greater the income from growing wood might be. To him, a bird in the hand is worth two in the bush.

Moreover, such things as taxation and protection are a constant bugaboo to getting land owners to grow timber on their holdings. These costs pile up pretty fast and when reforestation or afforestation is necessary the red in the books has mounted up to quite a sum before there is much income from the land. Wherever grazing can be practiced without hindering the establishment of timber, it appears that it is well worth considering as a revenue producer to help carry the load until some wood is ready for market.

To attempt any such procedure, however, would first require:

1. Carefully conducted studies to determine the conditions under which grazing may be carried on without injury to the timber.
2. The working out of pasture or range management methods to follow for the given conditions.
3. Education of the land owner to practice regulated grazing.

As stated by Messrs. Stickel and Hawley in their reply to Prof. Cope, silviculture is local in its application. The same is true of grazing in relation to reproduction. In some places, such as the pine lands of New England and doubtless elsewhere, regulated grazing may be practiced to advantage. There are other places where grazing will probably have to be kept out altogether. Consequently, studies such

as the one by Stickel and Hawley in New England should be welcomed and encouraged.

Pasture management is one of the most neglected phases of American agriculture. This is especially true on the small holdings in the timber regions where grazing is only a side line and hence given less attention than it might otherwise receive. Not only are pasture lands in the East given little attention, but in many instances information is lacking as to how they should be grazed. Probably it is wise, therefore, to go slow in attempting to graze timber lands until more information is available as to where and how it may be done. But after all, isn't that part of the whole problem? Any phase of agriculture must be properly balanced with other phases and insofar as possible, livestock production should be harmonized with timber production. The problem of grazing on timber lands is, therefore, a problem of forestry not to be side-stepped but to be given due consideration along with growing timber, protection against fire, insects and disease and other related problems.

A NOTE ON HARVARD FOREST SILVICULTURE

BY R. T. FISHER

Director of the Harvard Forest

Messrs. Preston and Woolsey in their debate on American silvicultural practice during the past quarter century have made some stimulating points. Such in my case are the references to the Harvard Forest (May and June Journal, pp. 497 and 501), which suggests in the first place that an intelligible summary of what Woolsey calls "the most intensive attempt at intensive silviculture" has never been set forth, and second, that certain regional and strictly local factors in the problem have not been sufficiently appreciated.

At Petersham in sixteen years of experimental groping we have reached the conclusion that the principal cover (present) types must usually be converted into a different composition before any consistent and enduring method of natural reproduction can be defined. Especially does this apply to the white pine type. *Temporarily*, and because of its usual old-field origin, the most uniform type in the region, it exhibits as it nears merchantability a wide range of tendencies toward altered composition and productiveness. Our struggles with this type very forcibly indicate how elusive is silvicultural practice in man-made types.

Woolsey's friendly references to Harvard Forest policy do not quite give the whole story. He says that "the main lesson from the Harvard Forest is that the practice of silviculture means living with the forest, learning its several stands,—” Yet he does not seem to interpret our varying treatment of the pine type as a consequence of this observed variability in the individual stand, nor does he appear to realize that we are aiming at the very thing that he advises, namely, mixtures of softwood with the more desirable species of hardwood in proportions varying with the character of the site. The following are his comments on our methods: "—the attempts there to get natural regeneration of softwoods have been made successful by *planting!* Probably this was poor silviculture—should not the Harvard Forest have been content with hardwoods with a sprinkling of softwoods? At Harvard, there is some silviculture to be seen, but I wonder if the real cost of such intensive work is appreciated. Couldn't relatively satisfactory results have been secured with less planting and more natural regeneration? For a time at least the objective was to get

conifers in opposition to hardwoods. Perhaps today Fisher would welcome more hardwoods."

In Harvard Forest Bulletin No. 1, published in 1921, the following sentence occurs: "It has now come to be the settled silvicultural policy to reproduce the pine type with a stand of mixed pine and hardwood." In arriving at and developing this main purpose we have cut some three million feet of pine sawtimber. For a time, as Woolsey says, "the objective was to get softwoods in opposition to hardwoods." From this point of view and in earlier years we made many and instructive failures, but in sum total we have got over ninety per cent of our annual cutting areas reproduced to sawtimber species either mixed pine and hardwood, or pure hardwoods, in the proportion of about four acres of the former type to one of the latter.

It is true that on about half of the areas reproduced to mixtures of pine and hardwood we have secured the pine by planting. This, however, is not because we have failed to get natural reproduction, but because we have found that in certain conditions of stand and on the heavier soils it is cheaper and surer to start pine by planting in groups than by the shelter-wood method, which has proved successful on the lighter soils where hardwood advance growth is not abundantly present.

As to the hardwoods, we do welcome them, not only for the excellent reasons that Woolsey gives elsewhere in his article, but because on the sites where hardwood reproduction is already plentiful under pine and therefore obtainable with the minimum cost, it would be folly to try to reproduce pine. What our silviculture has boiled down to in sixteen years of experiment is first, the determination of the desirable type or species for the land, and second, the selection of the methods which for a given set of conditions will most cheaply and effectively create it.

It is a fair question which Woolsey raises, whether the "real cost of such intensive work is appreciated" and therefore justified. Intensiveness in forest management is a purely relative term. Whether a given method is too intensive or not depends upon the value of the yield which is brought about. A well stocked acre of the type the Harvard Forest is aiming to produce is worth even at present prices from \$600 to \$800. With such a gross return in prospect and not considering the probable higher stumpage of a generation hence, it seems to us that, here and for these conditions, to pay the cost of intensive silviculture is merely good business.

My justification for offering these amendments to Woolsey's comments is that I think our experience at Petersham begins to show what the development of real silviculture in a new country actually means. In the first place, it is plainly and first of all a regional problem, and beyond that it is even a problem of minor localities, of individual stands. The importance of economic factors is obvious and for the moment can be set aside. The natural factors which alone concern the technique of silviculture are in central New England obscured and modified or temporarily altered by two centuries of human influence and varying use and abuse of the lands on which the bulk of the forests now stand. Roughly speaking, all our forests are either transitional or undesirable as to composition. They do not represent the free play of silvical factors, but rather the accidental result of past treatment of the land. The pure pine type, for example, occurs on every type of soil, but can be maintained by natural reproduction on relatively few. In short, if silviculture means the maintenance of desirable timber crops, then its proper development presupposes a preparatory stage, a period during which in all the complexities of temporary factors and accidental compositions, the desirable type must first be identified and then brought into existence. Many of the most valuable of our present cover types can not profitably be perpetuated because they do not belong where they are and because other types do. You can not talk about silviculture in the sense of controlled natural reproduction until you know that the type in question can actually maintain itself without undue assistance under management.

If it is true, as seems to be the general impression, that silviculture even for New England is still relatively undeveloped, then it is time that foresters should more clearly appreciate the nature of the problem. In New England we face a condition, not a theory, a condition of forests which will not behave consistently under treatment, which are full of undesirable elements, which exhibit contrary tendencies with the same composition, in short, forests that have got to be altered, converted, or got rid of. That is the first part of the problem, and that is the part which compels most first steps in silviculture to be compromises and makeshifts. The second part of the problem is to find out by experience in management and ultimately by more fundamental research, as we believe we have found out for certain sites on the Harvard Forest, what in fact are the desirable, the permanent, the self-maintaining types of forest. Inevitably this second phase of the problem has had but little attention because of the pressure for results,

the necessity for methods that will pay *now* on a particular property. There is a third and final problem in the life history of our silviculture that most of us today will hardly live to see. That will come when we have converted our present types into the ultimate or ideal types. It is then if our fundamental determinations have been sound, and if our woods experience has been sufficiently prolonged and localized, that we may hope to possess and apply a roughly standardized system of natural reproduction to a relatively standardized forest type.

COMMENT BY T. S. WOOLSEY, JR.

I have read Fisher's statement on Harvard Forest Silviculture. I am thoroughly in sympathy with his "Varying treatment of the pine type as a consequence of this observed variability in the individual stand," but I am not convinced that it is the most profitable method. I still want to be shown one thing. The actual honest-to-goodness cost of artificially introducing and *retaining* pine during the coming rotation on land which would otherwise probably carry pure hardwoods with perhaps a few white pine per acre. The interesting feature of Fisher's artificial introduction of white pine as compared with sound European practice is this: In Europe, pine is usually sown or planted on soils that *will not grow* first-class hardwoods. At Petersham, as I recall it, Fisher is introducing his pine on soils that *would grow* hardwoods. It is all right to speak of having timber worth six or seven hundred dollars an acre. That is a fine thing, but can the private owner afford to spend \$5 to \$30 an acre to secure these pine stands where nature would give them hardwoods if left alone, and will an acre of pine be worth so much more than hardwoods 80 years from now? (2) I wish there were more foresters in the United States doing exactly what Fisher is doing at Petersham. We need more of this sort of "research."

THE STATUS OF FORESTRY IN PORTO RICO

BY W. D. DURLAND

University of Porto Rico

In Porto Rico we hear and read much concerning forestry; the need for its practice and the value of its application, indicating and emphasizing the acute necessity for correcting the prevalent detrimental conditions of barren land and denuded slopes for which the island has long been famous. We hear and read little, however, concerning the actual solution of the problems involved or the gain or progress that is being made in this direction. In fact, following a careful survey of the forestry conditions in Porto Rico, in the writer's opinion, forestry is not being practiced at all, and unless proper pressure is brought to bear, it never will be practiced

It is granted that from a political standpoint forestry is needed, as Porto Rico is a timber stripped country and it must acknowledge its economic problems and appear competent to maintain itself favorably in the eyes of its guardian. From a practical and economic standpoint, forestry is needed also, and but a glance at the deforested slopes of thousands of acres of mountain land is sufficient to confirm this statement. The difference between the two viewpoints lies in the fact that political reward is immediate while practical and economic reward is a matter of the future requiring vision and a strict adherence to the problems, for a long period of time. Politics being of popular interest and of greatest favor in Porto Rico it naturally takes precedent over all matters and since the majority of the island's population is easily deceived, it is accredited as being associated with a progressive and scientific movement. As a consequence, forestry is talked of seriously, if inquiries are made, but in reality, beyond political affiliations, it is scarcely considered. The term is a misnomer.

Porto Rico was at one time densely wooded over its entire area. Due to years of cutting, burning and clearing in conjunction with a shifting method of agriculture, this forested area has been reduced on thousands of acres to barren land—denuded and exposed slopes. The problem confronting forestry on the island is unquestionably one of artificial regeneration to obtain wood production and a protective cover.

Forestry activity in Porto Rico dates back to 1898, when the island was under Spanish rule. Records indicate that provisions for the protection, maintenance and re-establishment of the forests existed at that

time but that they had never been effectively enforced. Engineers and other field officials in the government service were charged with the protection of the forested slopes; and a few of the most accessible mangrove swamps came under direct government supervision; but due to the negligence of the Spanish government, the end of the 19th century arrived with the passing of the island's jurisdiction into American control and the disappearance of the great wealth of original forests.

The first two decades of the 20th century (1900-1920) were, under American government, unprecedented periods of progress and development for Porto Rico. President Roosevelt in 1903 took definite steps toward the establishment of a forest policy for the island by creating the Luquillo National Forest of 12,000 cuerdas¹ from Spanish crown lands. (January 17, 1903.) On July 1st, 1917, this unit was placed under the administration of the United States Forest Service. Subsequently 3,000 cuerdas of adjoining public lands belonging to the insular government of Porto Rico were transferred to federal jurisdiction of the United States and included as a part of the Luquillo National Forest, making the present total land area embraced within this forest land unit as being 15,000 cuerdas. It is located in the "Sierras de Luquillo" which form a monadnock group of mountains in the north-eastern section of the island. It is a protection forest sparsely covered with a wild growth of small and inferior tree species of poor quality.

A division of forestry, within the Department of Agriculture of the insular government of Porto Rico was created by law in 1917 but due to the lack of financial support it was not actually established until 1919.² During the years 1918-1920 inclusive, 40,000 cuerdas of public lands, designated as being non-agricultural in character, were proclaimed Insular Forests and by virtue of the forestry law these areas came under the supervision of the Department of Agriculture.³ These land units are distributed as follows:

¹Cuerda is the Spanish term for acre. In Porto Rico 1 acre=1.029 cuerdas; 1 cuerda = 42,306 square feet.

²Amounts appropriated by the legislature for the ensuing two years. 1919-1921, \$18,400.00; 1921-1923, \$29,565.00; 1923-1925, \$38,705.00. See Laws and Legislative Acts of Porto Rico.

³Proclamation of the Governor dated May 28, 1918, Administrative Bulletin No. 143; proclamation of the Governor dated December 22, 1919, Administrative Bulletin No. 159; proclamation of the Governor dated November 11, 1920; administrative Bulletin No. 207. For the Forestry Law see Act No. 22, Legislature of Porto Rico, November 22, 1917.

Fifteen thousand cuerdas comprise the insular mangrove swamps, which are scattered along the coast in the littoral belt in some 20 different municipalities. These contain woody growths of white, black and red mangle, which is, for the most part, too small for cutting. It will be 10 years and more before they can produce any significant quantity of wood and then fit for fuel and charcoal purposes only.

The upland insular forest units consist of four areas. The Maricao forest area which contains about 5,000 cuerdas of moist mountain land, is situated near the town of Maricao on the western end of the island. About 3,000 cuerdas of this area are covered with a wild woody vegetative growth, composed of inferior species having little economic value. The remaining 2,000 cuerdas is barren and denuded land. The Guanica Harbor and Point Barraca forest areas contain together about 6,000 cuerdas and are located adjoining each other on very dry, arid and exceedingly rocky land, on the south side of the coastal hills, east of Guanica Harbor. Practically all of the land within these areas is too rocky for any forest use. The climate of its location is unfavorable for tree growth. Cattle are run on portions of the areas but the grass growth is so scanty that even this use is scarcely justifiable. They constitute waste lands, low in elevation, and as such have no value for forestry purposes. The Mona Island forest unit is located on Mona Island which lies about 100 miles off the west coast of the island of Porto Rico. It contains 14,000 cuerdas of land, 13,000 of which are too dry and rocky to support tree growth. The island is difficult to reach and while 1,000 cuerdas of the area are adaptable for forestry purposes, the isolated and uninhabited condition of Mona Island renders practical use highly problematical from a forestry standpoint.

Collectively, the forest land area under government ownership or control (55,000 cuerdas) forms but 2.5 per cent of the total land area of Porto Rico (2,200,000 cuerdas) which, when expressed in terms of land capable of forest production of economic value (Maricao forest unit 5,000 cuerdas—Luquillo forest unit [Federal.] 15,000 cuerdas—Mona Island forest unit 1,000 cuerdas—totalling 21,000 cuerdas) is reduced to less than one per cent of the total island area. 34,000 cuerdas (55,000 minus 21,000) of the land within these government forest units is discarded as land unsuited for the production of wood crops.

Ninety-four and three tenths per cent of the total land area of Porto Rico is held by private owners. Consequently it can readily be understood that it is through this medium that forestry must work if any material progress is to be made in forest regeneration. It is

quite unlikely that the island government, even with its present pretense at being a progressive and respectable dependency of the United States, could or would make a financial outlay in support of such true and sincere forest activity as the purchase of the necessary land areas would involve. The experience of the past eight years (1917-1925) does not indicate their inclination to be in this direction. There remains then but one obvious course for forestry to take if it is to become effective in Porto Rico and that is through the medium of the private owner. From the standpoint of the private owner he is ready for forestry since he recognizes that idle non-agricultural land is a liability and is eager to convert such land into a profitable investment; but, can this same private owner be expected to jeopardize investments of time and capital, in addition to the land values, in order to establish forest plantations, without reasonable security that

LAND STATUS IN PORTO RICO

Total land area.....	2,200,000	cuerdas	100 %
Privately owned lands.....	2,073,847	cuerdas	94.3% ^a
Publicly owned lands.....	126,153	cuerdas	5.7% ^a
Forest land area under government ownership or control	55,000	cuerdas	2.5% ^b
Area of forest land under government ownership or control, suited for wood production.....	21,000	cuerdas	0.9% ^b
Area of forest land under government ownership or control, unsuited for wood production.....	34,000	cuerdas	1.6% ^b
Area of land in actual cultivation.....	550,000	cuerdas	25.0% ^a
Area of pasture and grass land.....	550,000	cuerdas	25.0% ^a
Area of forest brush and waste land.....	1,100,000	cuerdas	50.0% ^a

^a Statistics of Department of Finance, P. R., latest available, 1910.

^b Footnote 3 and personal observations.

they will grow and progress to a profitable maturity. No—but he is ready to be convinced and if practical he will comply. Common sense is the confirmation. The course for forestry in Porto Rico then, being so clearly and well-defined—what is being done about it? Although eight years have passed since forestry became a part of officialdom, it is to be regretted that the insular government is in no better position today than at the beginning to intelligently advise the private owner of forest lands as to what he may best do and expect. The cart is before the horse. Time and money are spent advertising the necessity for forestry and that which ought to be done for the welfare of Porto Rico, when all of this is generally well recognized. Facts are required if the private owner is to establish forest plantations. He is not to be deceived for it is his personal property, time, money and interests that are at stake and he demands adequate proof of the financial security to be had

for forest plantations. The problem, because of the lack of established precedents in forest regeneration in tropical regions similar in conditions to Porto Rico, is intricate and complex, but it can be solved. The criticism hinges around the point that no definite or sincere effort has ever been made to seek the solution in spite of the fact that government paraphernalia and financial support is supplied for this purpose.

In tropical regions it is generally supposed that tree growth is both rapid and abundant. It would seem then, in order to be consistent with the popular belief, that forest plantation establishment in Porto Rico could be quite readily attained. This would be true were the factors of soil and competitive growth equally as favorable as the factors of climate. But the soil on the hill and mountain slope, volcanic in origin and which comprises practically the entire amount of forest land of the entire island, has under the influence of a deforested condition, constant warm weather and abundant rainfall, been leached out of its original nutrient constituents and the humus content excessively decomposed or completely washed away. These red, laterite soils, clay-like in mechanical analysis, that are extremely heavy and that pack and puddle badly, even to the extent of being impervious to both air and water, that are formed from lava decomposed through the action of alternating periods of drought and tropical rains, are those upon which Porto Rico is dependent for the re-establishment of her forests. Against favorable conditions of climate, coincident with the location of the majority of the forest land acreage, permitting almost a continual growing season, are found unfavorable conditions of soil which renders forest regeneration a procedure requiring more than a passing thought. In addition to abnormal conditions of soil, forest plantations have to contend with what is termed "maleza" which constitutes grass, weeds, shrubs, ferns and vine growth. This "maleza" grows so rapidly, occurs so abundantly and so densely and reproduces so prolifically and completely under any and all conditions of soil and climate that it requires continual attention to keep it from destroying young tree growth. It is costly to free a tree from "maleza" and since it readily returns to its former state of existence even when apparently completely destroyed, the expenses of "maleza" destruction necessary to preserve a forest plantation, almost immediately amount to an expenditure prohibitive of profit from the enterprise. Most native tree species are very susceptible to the ill effects of this competitive growth even when assisted by soil preparation and weeding. Few, if any, can survive it in direct competition; none, capable of producing quality wood material. Conditions require the selec-

tion and development of hardy types of seedlings of desirable tree species, having adequate and suitable root and stock arrangement, which, with a small amount of care when placed in the field, will dominate the area and grow to maturity within a period of time conducive to profit.

Considering the foregoing conditions which have a direct bearing on the reception of forestry by the private owner, can forestry in Porto Rico, wholly unequipped as it is with the necessary information whereby forest plantations may be economically and successfully established, expect the private owner to enter into a program of reforestation, hazarding capital in an exceptionally slow and risky game of chance? No—and it is the duty of forestry on this island to govern its affairs in an honorable and ethical manner, always being conscious of the fact that it exists to serve the public in an efficient manner and not as a portion of any political scheme or “idea” but, in the true sense of the word, as a “science.”

Furthermore, the distribution of propaganda can be carried too far, especially in a country small in size, where practically all occurrences quickly become known. Porto Rican forestry is fast approaching this stage if it has not already arrived. It must talk less about what should be done—the time has come for action.

The job at hand is not being attended to and for eight years (1917-1925) since the inception of forestry in Porto Rico's affairs, the barren condition of the island's mountain slopes has been lamented, trees of a few species have been produced in a government nursery and distributed broadcast as personal favors and although a satisfactory forestry law adorns the legislative records the results of its application indicate that the “science” of forestry in Porto Rico functions as but an agent for political prosperity. It is time that something was done for the material assistance of the establishment of forestry practice. A sufficient length of time is involved in maturing a tree crop without augmenting the period by indifferent attitudes.

NOTE: It appears from Mr. Durland's description of local conditions that the time has come for intelligent experimental reforestation on a considerable scale. It is to be hoped that the local government will supply the necessary funds.—T. S. W. J.

HASTENING THE GERMINATION OF SUGAR PINE SEED¹

BY ALLEN W. JACOBS

This investigation² was made to discover a method, or methods, of hastening the germination of sugar pine seed. Not only is the seed of sugar pine (*Pinus lambertiana*) notably slow to sprout but its final germination averages low. Considering in addition that this conifer is generally a light seed-producer, but little interest can be aroused in the planting of it. The high quality wood that sugar pine produces, its present value and commercial importance, and the rapid exhaustion of scattered accessible stands of old growth, make it urgent that its problems be given some attention. This paper is concerned with the first stage of the process of obtaining seedlings for planting, the germination of the seed.

A new term introduced in this report is Real Germination Per Cent, used to arrive more correctly at the germinative power of the seed in question. The distinction was believed necessary because of the wide variance in germination caused, as it was found, by the presence of many empty seed in some of the samples tested. The term Real Germination Per Cent was suggested by Rafn's (19) use of the expression Real Value. He uses this term to relate the final per cent of germination to the average purity of the seed. It is believed that the power of germination of a certain species of seed should be based, if possible, not on the original number of seed in the test sample, but on the number not empty. The empty seed can best be distinguished by cutting and examining, at the completion of the test, those seed remaining unsprouted. This method of analysis has the additional advantage, beyond arriving at a more correct germinative power, of giving the experimenter data on the condition of all seed left ungerminated. Those seed can be distinguished that are sound and alive, those that have decayed, as well as those that have been empty from the beginning. By reason of these advantages, the above method of analysis and comparison in the testing of seed is recommended for seed of such size as permit individual examination.

¹ Brief of a thesis presented August, 1924, at the University of California for the degree of M. S.

² For the helpful suggestions and advice received during the study of this problem and for friendly criticisms of this paper, an expression of thanks is due Professor Walter Mulford, and Doctors J. P. Bennett, I. C. Hall, and A. W. Sampson of the University of California.

MATERIAL

In order that fresh seed might be experimented with in the laboratory the aid of the Forest Service was enlisted. Forest rangers in four counties of California (Lassen, Placer, Tuolumne and Tulare) sent in a total of 195 freshly collected cones of sugar pine. These four lots of seed were numbered and kept separate throughout the period of examination. The extraction and cleaning of the seed followed methods employed by the U. S. Forest Service. The cones were dried on a tile roof where conditions were practically ideal, due to almost constant breezes and a month of sunny days. A maximum temperature of 39 degrees and a minimum of 7 degrees C., in the shade, occurred on the roof during this period. The extracted seed were dried for one week at the average room temperature of 22 degrees C. before being used for germination tests.

METHOD AND APPARATUS

Because of the large number of tests undertaken and the large size of the sugar pine seed, only 50 seeds were taken from each lot for a given test. Selection was made by the method of division and re-division of a large pile, until finally a sample of 50 seeds was counted out at random. As certain samples of seed are quite likely to show marked abnormalities three check tests of untreated seed were made for each lot, and the average of these tests was taken as indicative of the normal germinative power of the particular lot. Tests in the laboratory were carried on for a period of 120 days, and in sand out-of-doors for 140 days.

The bulk of seed testing was done in the standard oven or germinating chamber, that adopted by the Association of Official Seed Analysts. The oven used is heated by electricity. The thermostatic device was found to hold the temperature within a range of 2 or 3 degrees C., while the heating unit brings about a temperature rise of one degree C. in about one minute. The oven and all movable parts were sterilized at a temperature of 60 degrees C. for six hours. The samples of seed were placed between moist blotters for testing and were kept continually in a moist atmosphere by placing a pan of water in the oven bottom, just over the heating unit.

Six of the major tests carried on in the laboratory were duplicated in sand out-of-doors. Possible field or forest conditions were approached as nearly as possible. The seed for each test were placed on three centimeters of evenly-spread sand of light and uniform packing, and similarly covered to a depth of two centimeters. The boxes of moistened

sand were kept in a cool, shaded hollow for 110 days. No visible germination having occurred in this time, the boxes were then moved to a higher, exposed level of ground, for an additional 30 days.

PRETREATMENT OF SEED

A thorough examination was made of the published literature on the subject of germination and hastening germination of seed. A total of eight pretreatments were applied and such were repeated as had early showed an effect of marked increase in germination. Those pretreatments that failed to bring about any beneficial action at the end of sprouting period were:

Mechanical injury.

Electrical stimulation.

Steeping in hot water.

The treatments that were repeated because of the early evidence of beneficial action were:

Acid immersion.

Freezing temperature.

Soaking in tap water.

Action of diastase solution.

Within each pretreatment the seed experienced variations of that treatment. The first acid treatment was immersion of seed in 10 N. H_2SO_4 (1.84 sp. gr. commercial grade) for a period of three minutes. The seed were removed from the acid and washed in distilled water, and while yet moist placed in the germinating media. The second acid treatment differed in that the seed were placed to germinate without removing the acid film with distilled water.

Seed that experienced a freezing temperature were first wet in a stream of tap water for 10 minutes, then placed, single layer-wise, in cloth bags, above and below a three-centimeter layer of moistened sand. The freezing temperature consisted of cold storage at 12 degrees C. for 48 hours. After a gradual thawing out during a period of 24 hours, the seed were placed in the germinating media. The other low temperature pretreatment differed by subjecting the seed to three such freezings.

Soaked seed were the first to show signs of a hastened germination. The first pretreatment was a 54-hour soaking in tap water at the average room temperature of 22 degrees C. in open beakers exposed to air influences. The second and third treatments consisted of a similar soaking for periods of four and eight days, respectively.

The diastase used for pretreating seed was obtained by making up a five per cent solution of commercial malt, using distilled water. In the first treatment the seed were soaked for 3 days in the malt

solution, in open beakers exposed to air with its heavy freight of minute organic life. The repeated treatment varied in using only seed of Lot 1 and leaving them in the solution for six days.

RESULTS

The 195 sugar pine cones received from the Sierra range netted a total of 6,758 grams of clean seed. Twenty per cent of this weight, or 5,403 seeds, has been placed to sprout in the germinating apparatus. A total of 3,085 seeds were tested in the standard oven (and 1,200 in sand.)

The true index (germinated plus sound seed) of the germinative power of seed untreated and the consistency of result shown by the seed during the total period of sprouting after experiencing treatment, rank the four lots in the order 1, 4, 2 and 3 as to reliability of result. Related germination studies made (discussed in part only and but briefly) partly explain this constant variance in the four lots of seed. Seed of Lot 1 were best in appearance and condition, and those of Lot 4 were largest in size. Seed of these two lots were larger and heavier than the seed of Lots 2 and 3 and came from the largest and best-matured cones. The two better lots of seed gave both higher cutting and higher sprouting tests, supporting Boerker's (2) and Munns' (17) conclusions that seed of large size give the earliest, most rapid and highest germination. The preliminary cutting test gave 79 and 70 per cent sound seed for Lots 1 and 4, respectively. Seed of Lot 2, most inconsistent, were found to be generally very immature. Seed of Lot 3, which gave consistently the lowest sprouting value, were smallest in size and came from cones smallest and lightest in weight.

Favorable pretreatment. The effect of each of the pretreatments upon each of the four lots of seed is shown by Table No. I. Only such treatments as appeared beneficial with repetition of test are included in this table. The percentages in the samples judged originally not empty are given in the columns headed "X." The figures in columns *a*, *b*, *c* and *d* are then Real Germination percentages based on Column X. Column *a* shows actual germination, *b* sound seed not germinated, *c* dead seed, and *d* the sum of *a* and *b*.

The bold typed values are those that for a given pretreatment show germination to have been better than the average result obtained from untreated seed.

Immersion in acid for three minutes with washing brought about a marked increase in germination for Lots 1 and 3. This treatment

TABLE I
RESULTS OF 120-DAY OVEN GERMINATION AFTER VARIOUS SEED TREATMENTS.
(All values are percentages of filled seeds, except columns x which are filled percentages of the whole).

UNTREATED										TREATED											
Lot	Average of three tests					Acid 3 minutes					Exposure to Freezing										
											Once					3 times					
	x	a	b	c	d	x	a	b	c	d	x	a	b	c	d	x	a	b	c	d	
	1	76	18	45	37	63	80	55	10	35	65	86	70	28	2	98	60	60	0	40	60
2	23	42	9	48	52	6	33	0	67	33	12	17	67	16	84	18	22	0	78	22	
3	65	24	25	51	49	62	55	20	25	75	44	45	18	37	63	52	8	0	92	8	
4	55	53	2	45	55	68	50	41	9	91	50	92	4	4	96	38	11	0	89	11	
TREATED																					
Lot	Soaking										Diastase 3 days										
	54 hours					4 days					8 days										
	x	a	b	c	d	x	a	b	c	d	x	a	b	c	d	x	a	b	c	d	
	1	66	55	0	45	55	92	93	0	7	93	62	32	3	65	35	98	82	18	0	100
2	42	0	0	100	0	30	60	13	27	73	8	75	0	25	75	14	71	14	15	85	
3	70	9	3	88	12	32	25	6	69	31	56	0	4	96	4	48	4	0	96	4	
4	70	9	0	91	9	44	91	5	4	96	90	58	7	35	65	42	38	0	62	38	

seemed too strong for seed of Lot 2 with an increase of dead seed, while for Lot 4 the effect is less clear with a large decrease of dead seed over normal being noted but no increase of germination. Dipping seed momentarily in acid without washing resulted in over 90 per cent dead seed in all oven tests.

Exposing the seed to a freezing temperature for 48 hours with a gradual thawing-out brought increases of 21 to 52 per cent germinated seed and is also noted to have resulted in large decreases of dead seed with Lots 1, 3 and 4. Repeated freezing was much less beneficial to Lot 1 and otherwise resulted in increases of 30 to 44 per cent dead seed, being thus generally detrimental.

Soaking seed for 54 hours in tap water in open beakers proved of some benefit to seed of Lot 1 but otherwise the effect was to double the amount of dead seed. Soaking for four days proved to be the most beneficial not only of all periods of soaking but of all pretreatments experimented with in this study. The effect of a 4-day soaking was most marked with Lots 1 and 4, which lots evidenced rapid germination from the very start with per cents of 80 and 73, respectively, being reached in a period of 20 days. This is an unusually early and rapid germination. Soaking for 8 days brought inconsistent results. Dead seed were increased for Lots 1 and 3, Lot 2 appeared to be considerably benefited, and Lot 4 was not affected materially.

Soaking seed in diastase in open beakers for 3 days brought about increased germination of Lots 1 and 2, stimulated the early sprouting of Lot 4, but with Lots 3 and 4 no 120-day benefit is noted. Except for the few seed sprouting early with these latter lots, all seed were found to be dead at the completion of the tests. This same detrimental action is to be noticed with all four lots following the three-time exposure to freezing temperature, the 54-hour and the eight-day periods of soaking.

Briefly summarizing the above pretreatments for all four lots, germination was increased in the following order, the most beneficial treatment being given first.

Table II shows that soaking four days and a single exposure to freezing have resulted in the highest increases of germination.

Results of tests conducted in sand out-of-doors are presented in Table III. Much less weight should be given to these results, as none of these tests were duplicated and exposure to freezing was the only pretreatment repeated:

TABLE II
EFFECT OF PRETREATMENT ON GERMINATION

Rank of Treatment	Number of Lot			
	1	2	3	4
1	Soaking 4 days	Soaking 4 days	Acid for 3 min.	Freezing once
2	Freezing once	Diastase	Freezing once	Soaking 4 days
3	Diastase	Soaking 8 days		Soaking 8 days
4	Acid for 3 min.			

TABLE III
GERMINATION PERCENTAGES IN SAND

Lot No.	Untreated seed	Acid	Freezing once	Freezing 3 times	Hot water	Soaked 4 days	Proportion of filled seeds
1	91	100	12	69	6	98	84-98
4	86	97	38	88	53	80	64-90
Average	88	98	25	78	30	89	74-94

The figures above are real germination per cents, based on the number of seed possessing embryos. The last column indicates the relatively high number of these seed, the range given being for test samples covering all five pretreatments. Only the results with seed of Lots 1 and 4 are given. The seed of poorer quality in the other two lots gave no consistent results, due to the large number of empty seeds in the test samples, which ran as high as 74 per cent.

From a comparison of the above real germination percentages, it is shown with germination in sand that acid treatment is beneficial to sprouting, regardless of the high normal germination obtained. Soaking four days was the only other pretreatment giving a higher germination than untreated seed. These high percentages of normal germination in sand are due, it is believed, to the 110-day period of rest experienced by the seed in the cool canyon shade, with the same effect as stratification mentioned by Howard (12) and Rafn, and more recently by Wahlenberg (24), who found that fall-sown seed of white pine average a more prompt and complete germination than do spring-sown.

DISCUSSION

The real germination percentages of untreated seed of Lots 1, 2, 3 and 4 of 18, 43, 24 and 53, respectively, in a testing period of 120 days are values well within the average germination of sugar pine seed as given by Larsen and Woodbury (15) and Toumey (23).

Unfavorable pretreatment. Of the pretreatments at first appearing decidedly unfavorable to germination of sugar pine seed, mechanical injury resulted in much decay of seed by reason of entrance of injurious fungus spores through the wounded testa. Harrington (10) discusses this danger of decay due to the impaired protective character of the seed coat. It was noticeable that the fungus growth had no detrimental action upon the initial stages of germination, unless it be hindrance to entrance of water, but rather upon the subsequent growth of the radicle after emergence.

The electrical stimulation of seed was unfavorable with all of the tests made. A high voltage of static electricity was used, which is believed to have so excessively shocked the embryonic plants as to kill them. Inspection showed most of the seed to be dead at completion of tests. This field of treatment is a large and rather indefinite one and needs long and careful study and experimentation in order that any fair results may be obtained.

Steeping seed in hot water at 49 degrees C. for two hours appeared at first to somewhat benefit germination, but as the sprouting period progressed this apparent benefit was lost. Toumey and Boyce (3) believe that soaking in hot water favors germination. Studies of Ewart (7) and others signify such treatment more applicable to species of seed with a thick and dense coat, as possessed by the legumes.

Favorable pretreatments. Immersion of seed in acid is one of the favorable treatments tried believed to be a practical means of hastening the sprouting period. This favorable action (Hartley—11) is apparently due largely to the sterilization of the seed against fungus infection, when in an environment conducive to spore growth, and to a less extent to rendering the seed coat more permeable to entrance of water and possibly certain substances in solution. Crocker (6) and Ewart (7) discuss coat permeability at length and the possibility of certain beneficial physical and chemical changes that may occur within the outer layers of the testa. Ewart's warning that too long a contact may prove injurious rather than beneficial, especially with a thin-coated seed, is emphasized by results of certain acid treatments given sugar pine seed, with sprouting in the oven. Results of sand tests after similar treat-

ment give evidence of neutralization of the acid film by soil solutes. Other investigators as Love and Leighty (16) and Harrington (9) have found application of acid increases germination, while Pack (18) and Lakon (14) found certain species unaffected. The nature and result of the action from acid and the treatment to be applied to the seed varies with the different species of plants, as plants and their seed vary in physical character and inherent qualities.

Exposing sugar pine seed to a single 48-hour period of freezing temperature evidently aids sprouting, largely through alteration in physical character of the integument and possible beneficial food changes within the seed. Repeated exposure to freezing combined with successive thawing out at much higher temperatures results in the death and decay of the embryo. Examination of seed subjected to 12 degrees C. for 48 hours showed that the embryo and endosperm remained unfrozen, and that the outer part of the testa was considerably altered in structure and character. Thisel-Dyer (21) and Brown and Escombe (5) state that seed are unharmed by long exposure to extreme low temperatures with no effect on germination, while Haack (8) finds that such action is beneficial to pine seed.

Seed soaked in tap water at room temperature were the earliest to show signs of hastened germination. Larsen and Woodbury's report on the moisture requirements of sugar pine during growth and of the seed during germination, and the discussion of Howard and Crocker of seed coat behavior added significance to this observation, the early and rapid sprouting of soaked seed. A period of about four days under the given conditions of temperature and moisture is shown to be the most effective pretreatment with sugar pine seed. This treatment brought about germination as high as 93 per cent in the oven and 98 per cent in the sand, in a period of 120 and 140 days respectively. Too long soaking, as Harrington states, is doubtless harmful. Soaking is most effective with fresh seed directly after extraction from the cones, an observation concerned with the subject of the rest period in seed. Tests not included in this report show agreement with Bates (1) and Boyce (3) and Tilletson (22) that an increase in age brings about a decided decrease in vitality and power of seed to germinate, and that old seed germinate much more slowly.

Action of bacteria. The effect of soaking seems largely a bacterial influence, as seed entirely submerged for 22 days in distilled water in sealed containers gave only slight increases in germination. With the usual method of soaking in tap water greatly increasing numbers of

bacteria were found in the solution surrounding the seed after the second day. No time was available for procuring pure cultures, but due to their great predominance it is believed that most of the favorable changes are brought about by the genus *Bacillus*. The writer is indebted to Dr. I. C. Hall who suggested placing the seed in certain sterile solutions. Iodine and phenol each in solution 1 part to 100 parts of water are thought to have caused the death of many seed through the penetration of the testa, but iodine 1-500, mercuric chloride 1-2,000 and sodium hypochlorate 1-1 did not materially injure the seed, yet gave only a germination of 13 per cent in 30 days, which is about the average for untreated seed. It is therefore deduced that the hastened germination caused by soaking came about through the presence and action of a great number of bacteria in the solution containing the seed. Knudson (13) found that inoculation of orchid seed with bacteria raised the germination.

It is thought that a large part of the higher germination resulting from seed soaked in diastase is caused by this effect of bacterial action with prolonged soaking rather than by the action of diastase itself, which latter serves as a rich diet for bacteria. About the same stage of bacterial growth and activity was reached in tap water in eight days as in diastase in three days, which fact may explain the similar results of sprouting following these two pretreatments. Also, it is probable that seed exposed to low temperature owe much of the favorable germination ensuing to the subsequent action of bacteria present in the tap water with which they were wet.

Braun (4) states soaking stimulates the bacteria dormant on the seed coat into vegetative activity. The first change observed to take place with seed in tap water is the evolution of gas that begins within the hour. After a day the solution begins to have a pronounced odor and the color and density change markedly. At the end of four days the solution has become a veritable sea of bacterial life and there has taken place considerable disintegration of the testa and swelling of the seed organism. The increased germination following the soaking of seed may be due in part to the physical alteration of the seed coat, as Crocker suggests, and as Ewart found who experimented with seed of *Chenopodium* and other hard-coated species.

A further observation by Knudson was that bacteria may favorably influence the development of chlorophyll in the plant. This observation and one made in this study may throw light on the subject of hastened germination. It was found that a large proportion of the sound un-

germinated seed of certain samples at the end of the sprouting period, under knife, disclosed a considerable development of chlorophyll in the embryo. In all cases the seed that had developed chlorophyll were of samples treated by soaking or exposure to freezing before entering the 120-day stay in the darkness of the germinating chamber. It is a known fact that chlorophyll will develop in complete darkness, but the action is little understood. A suggestion is that bacteria may have an influence in the growth and development of plant life kindred to that of light, and in the absence of light these minute organisms may bring about a similar response on the part of the plant. Nature has so carefully and minutely provided the means for development in all life that certain of her agents may have similar and reciprocative powers, the power to supplant from a new origin any urgent need arising through loss of the former source.

Rest period. A study of the process of germination of sugar pine seed shows that some seed germinate early, that many sprout after a period of 120 days, and that sprouting occurs in general at irregular intervals during the incubation period. It is evident that sugar pine seeds experience a rest period. From this state of dormancy they awaken to begin growth under conditions favorable to the inception of germination, but at no interval common to all. The whole problem of hastening the sprouting of sugar pine seed seems to be the existence of the rest period, and of bringing to bear upon the seed that influence or combination of influences of a reactionary and reciprocative nature that will interrupt the rest period and promote immediate germination.

The general shape or trend of the curves showing the progress of germination of untreated seed and of treated seed is the same. The high germination increases obtained have been simply a result of earlier and more rapid sprouting brought about through shortening, by a certain number of days, the rest period of each individual seed. Howard notes the variation in the rest period of seed, and he, Harrington (10), Ewart and many others observe the persistence of dormancy. The importance of the seed coat in this respect has been mentioned, which with seed of the sugar pine is believed to play a less important role. It is significant that seed of this species in many instances will remain dormant when placed in a situation favorable to germination, though this species has medium thick to thin seed coats rather permeable to light, air and water. It is probable that necessary food changes within the seed and attendant biological processes play a more important part in the delayed germination of sugar pine seed. The combined influence of many fac-

tors, notably bacterial action, as mentioned in this paper all contribute to affect this little understood phenomena of Nature, the initial impulse of the germinating seed.

SUMMARY

1. The normal germination of sugar pine seed based on 12 tests conducted for 120 days is found to vary from 18 to 53 per cent. The seed tested represent the distribution of this species in its Sierra range in California.

2. The quality is apparently affected by both the size and weight of the seed, and the stage of maturity reached. Large and heavy seed, well-filled and freshly mature, germinate more rapidly and completely than do smaller, immature or over-mature seed.

3. Mechanical wounding with subsequent fungus infection, excessive electrical stimulation, hot water treatment, or too long an application of acid all fail to increase germination.

4. Soaking for four days and exposure to freezing for 48 hours, of all pretreatments tried, are found most favorable to induce the early and complete sprouting of sugar pine seed.

5. A few unrepeatable tests carried on in sand show it to be the best medium for germination of this species of seed, especially if seed previously experience a period of stratification.

6. The consistently beneficial action of soaking is considered due to action of bacteria in tap water, exposed to air. The soaking of sugar pine seed in open containers of undistilled water is recommended as a possible means of obtaining a high percentage of vigorous seedlings in the nursery bed.

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RELATION BETWEEN ABNORMALITY AND INSECT ATTACKS IN WESTERN YELLOW AND JEFFREY PINE STANDS

BY RALPH HOPPING

A very prevalent common belief seems to exist among technical foresters that insects attacking and killing trees select individuals which are weakened by attacks of mistletoe and fungi or are injured in some other manner which reduces the vitality of the tree. Field experience, however, suggests a doubt as to the accuracy of this belief which does not seem to be supported by carefully taken and tabulated data.

The figures in this article pertain to 1656 trees attacked by the killing bark beetles of *Pinus ponderosa* and *Pinus jeffreyi*. These are known as the Western Pine Beetle (*Dendroctonus brevicornis*, Lec.) and the Jeffrey Pine Beetle (*Dendroctonus jeffreyi*, Hopk.) Each tree has been cut and peeled and the bark and limbs burned to destroy the beetles infesting them. The area upon which these trees were cut and examined included the entire watershed of the Susan River in the Lassen National Forest in California.

Before submitting the tabulated data it seems advisable to make a few comments on the injurious factors, mistletoe, decay and lightning. The criticism might justly be made that we do not know to what extent these factors exist in the remaining stand not attacked by the beetle. An extensive survey of the area, however, has convinced the writer that only a proportional amount of mistletoe trees had been attacked and killed, and an examination of mill cuts on representative areas also indicates that the trees with decay or heart rot are likewise proportional.

The reverse, however, is true of trees recently struck by lightning. If there is epidemic infestation within the area every lightning struck tree becomes infested. If, however, the infestation is very slight on an area, lightning struck trees often escape being attacked. Healed lightning scars of trees struck many years ago are quite frequent in some parts of the forests. Trees struck by lightning seldom die from the shock unless badly shattered. It may therefore be said that these destroying beetles prefer and select trees struck by lightning, but do not particularly choose trees weakened by attacks of mistletoe or fungi, as many of the latter trees remain in the forest unattacked

while over 50% of healthy trees are attacked. If in epidemics these destroying bark beetles did select all the weak trees first, they could be used as a factor in sanitation, checked by man when the weak trees had been destroyed and only the healthy trees were left.

The area upon which the data were taken sustained in the years 1916 and 1917 a loss of over four million feet of timber due entirely to the above mentioned species of bark beetles, notwithstanding the fact that the loss in 1917 was greatly lessened by the control work of 1916. In the following tables it will be noticed that the percentages for mistletoe and decay are fairly constant for the two years. Necessarily lightning trees would vary according to the prevalence of lightning storms and the number of trees struck during a particular season.

EASTERN LASSEN PROJECT

TABLE I.

Species	Year	Mistle-toe	Without Mistle-toe	% With Mistle-toe	Total Trees	Notes
Pinus ponderosa	1916	65	344	15.6%	409	12 with decay and two with lightning
	1917	31	184	14.4%	215	3 with decay
Totals....		96	528	15.4%	624	

TABLE II.

Species	Year	Decay	Without Decay	% With Decay	Total Trees	Notes
Pinus ponderosa	1916	45	364	11%	409	12 with mistletoe and two with lightning
	1917	23	192	10.7%	215	3 with mistletoe
Totals....		68	556	10.9%	624	

TABLE III.

Species	Year	Lightning	Without Lightning	% With Lightning	Total Trees	Notes
Pinus ponderosa	1916	16	393	3.9%	409	2 with mistletoe and 2 with decay
	1917	4	211	1.9%	215	
Totals....		20	604	3.2%	624	

TABLE IV.

Species	Year	Mistle-toe	Without Mistle-toe	% With Mistle-toe	Total	Notes
Pinus jeffreyi	1916	249	591	29.6%	840	20 with decay and one with lightning
	1917	29	163	15.1%	192	3 with lightning
Totals...		278	754	26.9	1032	

TABLE V.

Species	Year	Decay	Without Decay	% With Decay	Total Trees	Notes
Pinus jeffreyi	1916	87	753	10.2%	840	20 with mistletoe
	1917	16	176	8.3%	192	
Totals...		103	929	10%	1032	

TABLE VI.

Species	Year	Lightning	Without Lightning	% With Lightning	Total Trees	Notes
Pinus jeffreyi	1916	9	831	1.1%	840	1 mistletoe
	1917	6	186	3.1%	192	3 mistletoe
Totals...		15	1017	1.5%	1032	

TABLE VII.

Summary

Trees Species	Trees Weakened	Trees Apparently Healthy	% Weakened	Total Trees Cut
P. ponderosa.....	165	459	23.2%	624
P. jeffreyi.....	372	660	36.7%	1032
Totals.....	537	1119	32.4%	1656

The only other visible factor which might cause a decrease in vitality below the normal or healthy tree, would be old firescars. It is reasonable to suppose that as many of these firescars are small, the majority of them would not reduce the vitality of the tree. In order, however, to eliminate every possible factor I shall further deduct all fire scarred trees. These number 122 Yellow pines and 162 Jeffrey

pinus, or a total of 284 trees from the 1,119 apparently healthy. This leaves a balance of 835 trees which were apparently healthy or as healthy as any tree in the forest, each having a good crown and a full complement of foliage, or 50.4% of the entire number of 1,656 infested trees. As the infestation was pretty evenly distributed over the whole area and as numerous and quite evidently weak trees are still left on the area, the conception that tree killing bark beetles show a preference for weakened trees appears, at least for the area examined, not to be supported by actual facts. This, however, is not an isolated case, as the above figures can be duplicated by data collected on several other insect control areas in California.

NOTES ON NATURAL REGULATION AND GROWTH OF NORTHERN HEMLOCK AND HARDWOOD FORESTS

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Very little is found in our literature regarding the character of the virgin stands of northern hemlock and hardwoods (beech, yellow birch and sugar maple). Frothingham's excellent studies¹ are confined mainly to studies of yields from pure stands of the individual species, to investigations of aggressiveness of reproduction and to general silvical characters.

We recently had the task, however, of preparing a plan of management of a hemlock and hardwood forest in Wisconsin and, what is more, the good fortune of actually making the selection cuttings in accordance with the plan. The results of our studies may be of interest to the profession as a whole.

The forest is a typical hemlock and hardwood forest, slightly heavier in volume than the average, covering 1,800 acres of highland in northern Wisconsin. The soil is sandy loam, rather stony, and of only second rate value for agriculture. The site may be considered quality one for white pine and white birch, and a good quality two for hemlock, sugar maple and yellow birch. Occasional red oaks and butternuts are found; these are well developed, due likely to the influence of the forest cover, the red oak indicating the best growth and development of any of the hardwoods on the tract, being clean of bole and from 75 to 85 feet tall. White pine is 125 to 140 feet tall; mature hemlocks about 90 feet, and hardwoods 70 to 80. The site is nearly uniform throughout the tract.

The stand is heavy for northern hardwoods and hemlock, running over 14,100 feet per acre. About 8,600 feet is of hemlock; yellow birch is 1,780; sugar maple 1,120; white pine 1,550; the rest mainly white birch, Norway pine, basswood and beech. The pines came mainly from one heavy grove, covering about 30 acres, running more than 30,000 feet per acre, and nearly even aged about 160 years. It is obviously, therefore, a heavy uniform mixture, mainly of tolerants.

¹ Frothingham, E. H., The Northern Hardwood Forest, Bulletin 285, U. S. Department of Agriculture, 1915.

An analysis of the age or diameter class conditions of the average acre of the stand, as based on a 10 per cent cruise, indicates the following interesting conclusions:

The volume per diameter class rises uniformly from the 2-inch class to the 10-inch class; it remains almost precisely the same from 10 to 17 inches; then breaks abruptly and gradually tapers off to the largest trees, at 36 inches. This procedure is true both of hardwoods and the hemlock; and for all of the dominant hardwoods; and the rise, horizontal and fall of the curve is proportionately the same for all.

The 18-inch class has about three-fifths the volume of the 16-inch class; the 22-inch class about half that of the 18-inch. This is true for all species. Expressing this briefly in table form we get:

BASAL AREA BY DIAMETER CLASSES

D. B. H.	Hardwoods, Basal Area	Basal Area Conifers,	Totals, Basal Area
Inches	Figures are Square Feet.		
2-4	1.0	3.0	4.2
6-8	2.3	15.8	18.1
10-12	8.1	19.1	27.2
14-16	8.7	16.4	25.1
18-20	5.4	9.8	15.2
22-24	1.4	6.2	7.6
26-28	1.6	4.7	6.3
30-32	1.1	3.1	4.2

Apparently, so far as growth characters are concerned, these three species—hemlock, yellow birch and sugar maple—make truly a harmonious combination.

The remarkably even distribution of age classes is noteworthy. Taking the forest as a whole, there is no break in the even continuity of the age classes. This feature is also, more remarkable, because it holds good, not only for an average of the entire forest of 1,800 acres, but also for individual 40 acres. In fact, in any one winter's lumbering operation, over perhaps 120 acres, operating on selection basis, the distribution of age classes is so excellent that if one takes only trees above 17 inches there is no fear of seriously over-cutting or of under-cutting.

It is doubtful if man himself, working with these species on selection system, could do a better job of regulation. A simple diameter limit cutting may be done for all species and in all 40s with the assurance that neither the regulation nor the silviculture will be much in error.

It indicates also that there is a very definite natural rotation for the forest.

It is interesting that from the 10 to the 18-inch classes the growth almost precisely coincides with the death losses. Previous to the 10-inch class, the growth mounts steadily upward; after the 18-inch class it drops rapidly downward. This would indicate, but does not prove, that if one started with bare land the volume of the stand would be maximum at 10 inches, maintain it for 100 years and drop when the trees reached 18 inches. Thus, a stand 24 inches average diameter would not be as heavy in volume as one 12 inches. This is provided that no more trees came into the stand. It may also be surmised with much truth of conclusion that, if we start with bare land, by the time the stand has made one and a half cycles, i. e., in about 300 years, it will be nearly all-aged. Constantly trees are dying; constantly more trees are springing up from the ever continued seeding.

MANAGEMENT

We may consider, then, that this forest is well regulated in nature. A number of hold-overs of old age a few "sports" or oddities, which are to be expected, are not particularly troublesome.

Of course, individual acres do not have the perfect age distribution that the average acre does, yet it is truly surprising how nearly most of the acres do approach the mean.

The irregularities of age distribution are easily taken care of in cutting the forest.

If the forest, then, is considered well regulated as to age classes, we may consider that it will renew the growing stock in $\frac{\text{rotation}}{2}$ years.

If the natural rotation age is 200 years, then the forest restores itself in $\frac{200}{2}$ years, or in 100 years.

Editor's Note: The conclusions in the above article are based on the following assumptions which may result in serious errors:

(1) Perfect correlation between d. b. h. and age. Interchanging variables is dangerous. It may result in a change in the trend of the curve and so affect the "natural rotation."

(2) Law of growth in a many-aged forest identical with law of distribution of trees by d. b. h. classes.

In short, the stand of 14,100 feet per acre, is the result of 100 years of growth. This gives us, then, a growth of 141 feet per acre per year of the forest.

This growth, to be sure, is not net inasmuch as this virgin forest is losing as much volume each year as it grows.

This is a growth of just one per cent.

Working under a natural rotation of 200 years, then, we get an annual growth of 141 feet per acre per year; on a 20 year return, this amounts to 2,820 feet per acre to be cut. This is 20 per cent of the volume.

If the diameter limit is used in cutting, and this limit be set at 17 inches (natural rotation), we find that 32.5 per cent (or just about one-third) the basal area (volume) of the forest would be cut.

In order to make the cutting operation a feasible one to the logger, about 4,000 feet should be cut per acre. Cutting down to 17 inches, and including the cripples, undesirable specimens and trees injured in felling (trees under 17 inches), we get just about this volume as the average cut per acre.

Thus it is exceedingly interesting and important that if one cuts to a diameter limit of 17 inches (i.e., to natural rotation of the forest) just about *one-third* of the volume is taken—almost an ideal cut.

It is expected that, as a consequence of the removal of cripples, the very old, the wolf trees, etc., the forest will grow much faster, and a growth of about 300 feet b. m. per year will be obtained in the future. This is a growth of about three per cent per annum.

It is on this basis that the operation is being conducted. The simplicity, the ease of marking, the slight chance of making serious errors either of silviculture or of regulation, all tend to show that this virgin northern hemlock and hardwood forest is almost ideal for the easy practice of forestry.

An analysis of a hardwood stand, much dissimilar in site and composition to the one described in the preceding, was also made. This stand is 38 per cent beech, 12 per cent yellow birch, 27 per cent sugar maple, 8 per cent red maple and 11 per cent hemlock. A miscellany of balsam, spruce and white pine make up the balance. It runs about 8,000 feet per acre; soil is light sandy loam, entirely too light for successful farming, and the average height of the hardwoods is about 60 feet.

The average acre of nearly 9,000 acres shows, as did the average of the other, an almost perfect distribution of age classes; and practi-

cally the same volumes for all the age classes ranging from 12 to 19 inches. In the previous stand, it will be remembered, the stand ran evenly from 10 to 17; just why this present stand, on poorer soil, practically the same species, should run to larger diameters and presumably older trees and longer rotation, is difficult to determine. It is noted that there is a heavy percentage of beech, and perhaps beech is longer lived than the hemlock. Also, this present stand is not far from Lake Superior (6 to 10 miles) and the relative humidity may be much higher.

As with the first forest discussed, the diameter classes break in volume sharply, indicating apparently a definite natural rotation point at 19 inches diameter. Also, as with the other stand, each 40 acre tract exhibited almost a perfect distribution of age classes—in fact, almost each 10 acre piece.

Again it is apparent that selection cuttings, to a diameter limit, could be done with ease and with certainty of fair to good regulation and silviculture. The indications are that selection cutting in northern hemlock and hardwood, on all sites and with all combinations of species, is simple and safe.

SHORT CUTS IN MEASURING TREE HEIGHTS

By I. T. HAIG

Priest River Forest Experiment Station

The measurement of the heights of standing trees, an essential part of growth and yield studies, becomes in many regions of steep, brush-covered slopes a job of considerable magnitude. This is essentially true in the Western white pine type of northern Idaho and short cuts in height measurements, which have been developed by the experiment station for use in this type, may be of general interest.

Employing the Abney level as a hypsometer, the field measurements necessarily include (a) the angle subtended by the tree and (b) the slope or horizontal distance to the tree. Slope instead of horizontal distance is usually taken, because, in a region of steep slopes, it can be measured with greater ease and rapidity. When slope distance is taken, however, it is usually found necessary to leave height computations for the office and thus to suffer a number of disadvantages. Plots cannot then be allocated to site while in the field, and the number of measurements necessary to assure accurate height curves is determined more by guesswork than on any accurate knowledge of dispersion. Also a large amount of work in the form of height computation piles up for the office.

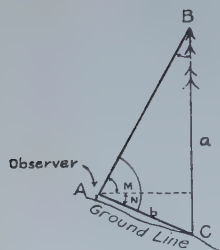
In northern Idaho and similar regions the ideal method would combine the measurement of slope distance with field computation of heights. It is the purpose of this paper to describe a special slide rule that renders this method a practical possibility.

This slide rule was developed after considerable experimentation with various arithmetical and graphic solutions for height. The simplest arithmetical solution is much too detailed for field computations and even in the office this method is far from satisfactory when a large number of computations must be made. (See Figure I.)

Donald Bruce suggested and outlined the construction of an alignment chart that enabled rapid graphic solution. This alignment chart was very much superior to the arithmetical solution but required two steps or settings in each computation and was rather difficult to adapt for field use.

It occurred to the writer that, as slide rules and alignment charts are closely akin, it would be possible to combine advantageously the scales of the alignment chart with the principles of slide rule construction. This was done and the result is a slide rule capable of solving

FIGURE I
SHOWING ARITHMETICAL SOLUTION



If $M = 50^\circ$
 $N = 9^\circ$
 $M + N = 59^\circ$
 b (slope distance) = 90 ft.

Find a (height of tree)

Now $B = 90^\circ - M = 40^\circ$

and $\frac{a}{\sin A} = \frac{b}{\sin B}$

or $a = \frac{b \sin A}{\sin B}$

Then

$\log b = 1.95424$

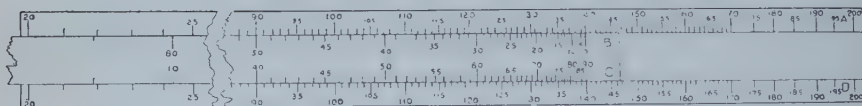
$\log \sin A = 9.93307$

$\text{Colog } \sin B = 0.19193$

$\log a = 12.07924$

Result $a = 120$ ft.

FIGURE II
SHOWING SLIDE RULE SOLUTION



for height with one setting. (See Figure II.) The same principles and indeed the same scales were employed that may be found on an ordinary slide rule, but the arrangement and graduation of these scales enable one to do the particular job with greater ease and dispatch. The solution is as follows:

Scale A Under Slope Distance

" B Set Angle to Tip

" C

" D

Under Total Angle

Read Height in Feet

The construction of the rule is very simple. All scales are in logarithmic terms, the A and D scales being logarithms of numbers from 20 to 200 and the B and C scales logarithmic sines of angles. If an ordinary 20-inch slide rule is available for use, logarithmic distances that are accurate to the nearest foot can be scaled off on proper-sized strips of paper and pasted over the ordinary scales of the rule. With skilled workmanship, rules of the same size could be made capable of computing heights to the nearest tenth of a foot, a greater degree of accuracy than is usually demanded for field work.

This straight slide rule solves the problem for office computations, giving a rapid, accurate and usable device for computing heights. For convenience in field use, the 20 inch straight rule can be calibrated in-

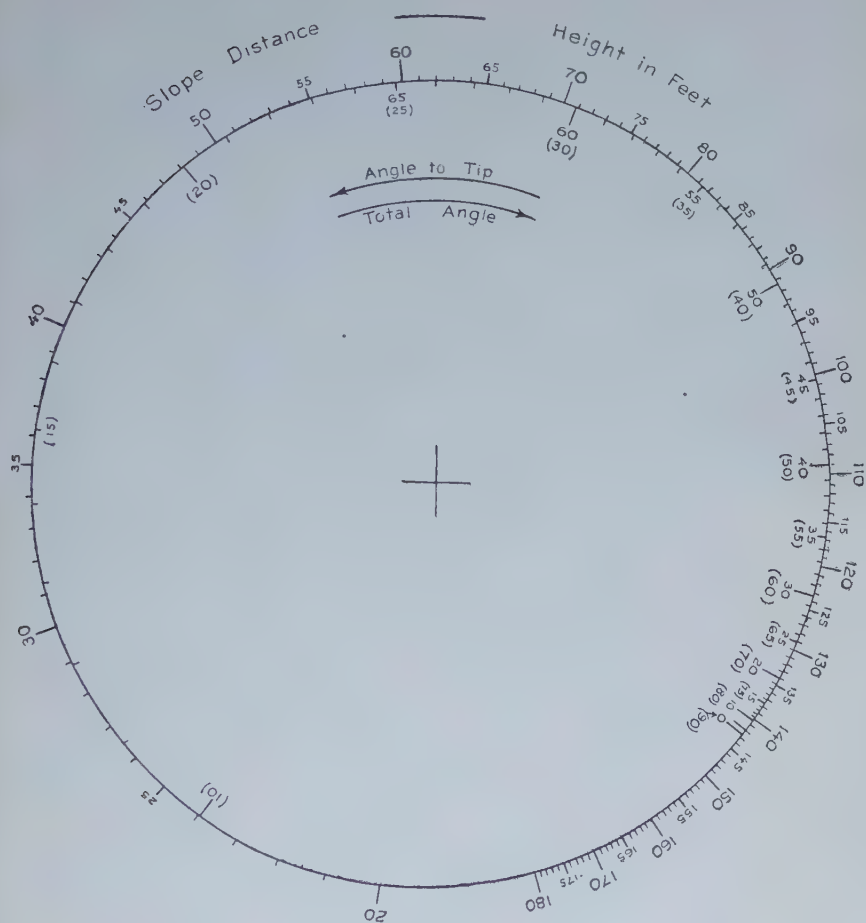


FIGURE III

Circular Slide Rule for Computation of Tree Heights

side of a seven inch circle and this circular rule can be fastened inside the cover of the tally holder.

A rule of the circular type is shown in Figure III. The principles underlying its construction are exactly the same as those applied to the straight rule, the scales simply being laid off around a circumference instead of along a straight line. Such a device is easily made in the office. The scales are measured off with the aid of a protractor or on polar coordinate paper and transferred to circular discs of the proper

size. These discs are then clamped together at the center. The rule is set by rotating one scale inside the other, with the same effect as that of moving the slide in a straight rule. With this device fastened inside a tatum holder facing the tally sheet, the tallyman should be able to record measurements and compute heights about as fast as the measurements can be taken.

In many steep, brushy regions slope distance should prove much easier to measure than horizontal distance, and there the device just described will effect a saving in time without sacrificing the advantages of reading heights directly in the field. It will certainly prove valuable in growth and yield studies in the Western white pine region.

Editor's Note: In Figure I Mr. Haig describes the process of measuring trees whose base is *below* the observer. If the base of the tree is *higher* than the observer, the formula becomes

$$a = b (\cos N \tan M - \sin N)$$

This will mean more than one setting of the slide rule but is still far ahead of the arithmetical solution.

A TEST OF TAPER TABLES

BY L. H. REINEKE

Office of Forest Measurements U. S. Forest Service

The general impression that taper tables may be used for the estimation of piece products equally as well as for the construction of volume tables may lead to serious errors, as pointed out by Baker.¹ To determine the magnitude of such errors in a specific instance the following test was made upon taper tables for southern white cedar.

A volume table in cubic feet was prepared from these tables and checked against the basic data. The aggregate difference was found to be 0.012 per cent and the average deviation was about the same as for the volume table prepared directly from the basic material.

These taper tables, thus shown to be very satisfactory for volume table preparation, were then used to estimate the probable yield of piece products. A considerable error was anticipated because (a) taper tables show average diameters at specified heights and not average heights to specified diameters, and (b) because taper tables indicate the average tree for each class, which is made up of a group of trees of which some are larger and some smaller than the average. In a case where the average tree just meets specifications the taper tables will indicate that all trees of that class will meet the specifications, whereas all those below the average (about half the total number in the class) will fail to do so. With piece products an excess in size of some of the trees will not offset a deficit in others.

Specifications were at hand for telephone poles and dock shores. As larger sizes are proportionately more valuable than the smaller sizes prices were used as the basis for the true evaluation of errors.

The basic data for the taper tables—405 trees—were used in these tests. Individual taper curves were plotted for each tree and from each curve was determined the pole and dock shore of highest value which could be cut from that tree. Similar values were determined from the taper table curves.

The estimate of telephone poles from the taper table curves showed 156 poles with a value of \$542.25, while the estimate from the basic data showed 153 poles with a value of \$590.30, an overrun of 8.9 per cent. This error is relatively small because (a) a large number of

¹Baker, F. S. "Taper Curves in Relation to Linear Products." *Proc. Soc. Amer. For.*, 1914, Vol. 9, pp. 380-387.

sizes—13—were specified, ranging from 25 feet in length, with a minimum diameter of 6 inches at the top and 8.9 inches at the butt, to 60 feet in length with a minimum top diameter of 7 inches and butt diameter of 18.1 inches, (b) only minimum diameters were specified and (c) all poles were accepted regardless of proportionate number of large and small poles. A considerable amount of compensation of errors was thus permitted because those curves which failed to meet the one set of specifications characteristic of their class might meet those for a slightly smaller or larger size.

The estimate of dock shores from the taper table curves showed 94 shores with a value of \$156.50, while the estimate from the basic data showed 156 shores with a value of \$288.50, an overrun of 84.5 per cent. The table shows the distribution of values.

Dock Shore Estimate

Size	From Basic Data	From Taper Table Curves	Overrun Per Cent
1	\$108.00	\$72.00	50
2	\$150.50	\$66.50	126
3	\$ 30.00	\$18.00	67
	<hr/> \$288.50	<hr/> \$156.50	<hr/> 84.5

The error here results from the fact that specifications limit both maximum and minimum diameters and but three sizes are specified, thus reducing the chance for compensation of errors. The last column shows the errors which would occur had only one size been taken. An overrun will usually result since some of the abnormal trees in many classes for which the taper tables show no pole or shore will be able to meet the specifications.

In the application of taper tables to piece product estimation one source of error is the interchanging of variables, which is done when taper tables (which predict average diameter at given heights) are used to predict average heights to given diameters. With perfect correlation between height and diameter no error would be involved, but lack of perfect correlation, always the case in tree data, introduces an error which, though small, is constant in sign. This error, while non-compensating, is largely obscured by other errors.

The major source of error is found in the fact that taper tables predict class averages. Approximately 50 per cent of the trees will

be above the average and 50 per cent below. In cutting sawlogs the large and small trees of each class are all included and errors are compensating; in cutting poles each piece must have a specified length and diameter and deficits in some poles can not be compensated by excesses in the others. Thus an error is introduced which, while of varying amount, may, as shown by these examples, be very serious.

REVIEWS

"Management Plan Custer Working Circle, Harney National Forest." Manuscript by C. B. Webster, U. S. Forest Service.

This working plan marks a distinct advance in forest management and gives in concise form a general description of the working circle covered, the economic situation, the management policy, the regulation of the cut timber sale policy and a specific cutting budget for 1921-1930. It is stated, "A general revision of this plan will be made for every ten year period and at the end of each cutting cycle. Minor revisions will be made every five years if conditions make it necessary." The plan seems business like and entirely practicable. The only question in the mind of the reviewer is whether it is necessary or advisable to list the stands to be cut by years for a decade in advance. With the rapidly changing conditions in the West, undoubtedly this cutting schedule will have to be modified. All the statistics are put in the Appendix and are cleverly arranged.

T. S. W. Jr.

"Forest Research Manual," by W. Gilchrist Wright, B. S., B. Sc. F., W. M. Robertson, B. Sc. F., and G. A. Mulloy, B. Sc. F. Published by the Forestry Branch, Department of the Interior, Canada. Ottawa, Canada. 9½ by 6½ inches, 93 pages, 5 half-tones, 4 line-cuts.

In Canada work in forest research has been carried on for some years past by the Dominion Forest Service and other agencies, notably by the Commission of Conservation, now discontinued. Several of the provincial forest services and a number of private business concerns have co-operated in the work.

During this period methods have become to a considerable extent standardized, and these methods are now published in order to secure uniformity in work, thus enabling the collection and comparison of results.

The book is divided into two parts, namely, (1) Problems and General Methods, and (2) Particular Problems and Methods. The first part occupies pages 5 to 28 of the bulletin, and, after a general classification of the problems (Sec. 2), gives definite directions for work under four headings, namely, Method 1: Permanent Plots for Periodic Examination; Method 2: Single-examination Plots; Method 3: Single Examination of a Series of Mechanically Selected Strips on the Lines of a Strip Survey, and Method 4: Single Examination of Single Trees. Definite directions are given, for example, as to the

choice, size, shape, survey, and description of plots, measurement of height and diameter, description of trees, and the use of forms for record. Under Method 3 (working-plan survey) are included directions for establishing base-lines, running strips, the treatment of types, mapping, calculation of increment, and permanent sample plots.

Part 2 consists of five separate articles, treating respectively of (1) Natural Regeneration, (2) Artificial Regeneration (Planting), (3) Yield and Normal Yield, (4) Thinnings, and (5) Statistical Methods applied to some Forest Problems. The article on Thinnings is illustrated by five half-tone illustrations. Of these, the first illustrates the effect of light on seedlings, and the other four (in two pairs) illustrate the effect of thinnings on the appearance of a stand.

Five appendices are included. The first of these is devoted to instructions for forms of record, and occupies 23 pages. The actual forms used, reduced in size, are given, those dealing with sample-plot work being shown filled out.

Other appendices deal with symbols for tree species, instruments, and forest terminology. Six general volume tables—two each dealing, respectively, with black spruce, white and red spruce, and balsam fir—conclude the volume.

"Jarrah and Karri in Building Construction." The Australian Forestry Journal, Vol. VIII, No. 6, June, 1925. Pages 152-156.

This brief article comments on the remarkable fire resisting qualities of these species of the Australian eucalypts. Whereas other woods burn and steel bends and buckles, jarrah and karri only char even when exposed to intense heat. A number of references are made to tests and observations of the non-inflamability of these woods. One official test conducted by the British Fire Prevention Committee in 1903, said:

"The test formed part of the program arranged by the committee in connection with the Annual Fire Congress and representatives of the Continental fire brigades were present, besides many others. A large brick hut 22 feet long by 10 feet wide was arranged with several lengths of karri timber two inches in thickness. These were placed so as to form a ceiling, and on top of them was a load of bricks weighing about seven tons. Coal gas was then turned on from a generator in the grounds and in a very short space of time the interior of the hut was red hot, the temperature at the end of two hours, the time fixed for the test, reaching close upon 2,000 degrees F. Notwithstanding this enormously high temperature, in no place did the fire burn through the wood and the load

of bricks remained undisturbed to the finish. The underpart of the planks—those in actual contact with the fire—were, of course, considerably charred; otherwise the wood was unharmed.”

A. E. W.

“*Tasmania State Forests.*” The Australian Forestry Journal, Vol. VIII, No. 6, June, 1925. Pages 156-7.

In the Tasmanian Forestry Act of 1920, it was specified that an area of not less than 1,500,000 acres should be dedicated as State Forest within seven years from January 1, 1921. The Act also brought into being for the first time a separate Department of Forestry, formerly administered as a part of the Lands Department. The organization of such a department and its gradual building up obviously occupied considerable time. The last year has seen considerable advance.

In addition to areas previously dedicated, considerably over 100,000 acres, comprising areas ranging from 500 acres to 40,000 acres, have been declared State Forests within the past 12 months. In the main, these areas consist of prime forest country and include large tracts of virgin forests of eucalypts and others of pines and blackwood.

The forest policy of the State is wide and comprehensive and embraces every aspect of protection and regeneration of indigenous forests, supplemented by plantations of exotic conifers, as an adjunct to their own valuable species. The interest and confidence of the public are becoming more pronounced. The Government is fully aware of its importance and the Lands Department, always favorable to most aspects of forestry, is also in perfect accord with the policy of permanent dedication.

A. E. W.

“*Tropical Woods.*” Number 2, June, 1925. Yale University, School of Forestry, New Haven, Conn.

This is the second number of the new publication begun by Professor S. J. Record in March, 1925, for the purpose of publishing the results of investigations and other information and data concerning tropical woods as it becomes available. This number is uniform with the first in size and character. The contents include the following:

Chemical analysis of balsa bark; *Schizolobium*: A promising source of pulpwood; Forest conditions in southeastern Bahia, Brazil; Flowers of Brazilian rosewood; Range of *Phyllostylon*; Pits with cibri-form membranes; *Montanoa*; Wooden combs; Spiral grain in trees; “Melon” and “Ronron” of Salvador.

This list denotes the variety of topics that are included and also betokens the value of the "Tropical Woods" series. Brief as are the comments or notes they are useful and would otherwise be buried in the files.

E. F.

"New Forests in East Anglia," by W. L. Taylor, Quarterly Journal of Forestry, Vol. XIX, No. 3, July, 1925. Pages 192-212.

This article is a discussion of the acquisition of land in the eastern counties of England by the British Forestry Commission for forestry purposes and the planting, protection, and administration of the forests. About 30,000 acres are under administration in these units.

The lands, bare of forest, must all be planted and this is done in plowed furrows after light burning. The species planted are mostly Scots and Corsican pines. Transplant stock and two-year seedlings have proven thoroughly satisfactory for planting purposes during the past five years, and over 3,000 acres have been planted to date.

Some experimenting in the direct sowing of conifers has been done with interesting results. Scots, Corsican, and maritime pine seed was used with remarkable success. It has been established for maritime pine, at least, that direct sowing can be accomplished easily and cheaply. The surface is burned thoroughly, and seed spots are prepared. A few seeds are sown in each patch and $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds of seed to the acre is all that is needed.

Elaborate measures are taken against rabbits and all plantation areas are enclosed by fine fencing. About six inches of the fencing is turned at right angles to the fence and laid on the surface of the ground outside the enclosure. This discourages the rabbits from burrowing under while "warreners" are employed to exterminate the rabbit pests.

A. E. W.

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Compiled by Helen E. Stockbridge, Librarian, U. S. Forest Service

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NOTES

GRAVES GROVE

On Sunday, September 6, at 2 P. M., the Save the Redwoods League formally dedicated and turned over to the California State Redwood Park System the recent gift of redwood forest from George Frederick Schwarz of New York. The Schwarz donation comprises 157 acres of magnificent redwood forest on the Redwood Highway 10 miles south of Crescent City, in Del Norte County, California, and was given in honor of Colonel Henry S. Graves, former Chief of the United States Forest Service, later Dean of the Yale School of Forestry and now Provost of Yale University.

The Graves Grove, as the addition to the park will be known, makes available for the scenic and recreational enjoyment of visitors to the redwood country an unusual attraction in its combined features of beauty and in its accessibility by train and automobile. Scenically it is one of the finest groves in the redwood region. Fronting the Pacific Ocean, the views through the giant trees, here growing almost to the water's edge, are of rugged coastal mountains, the long sweep of irregular shore line characteristic of Northern California, and to the west the open sea. The trees will be left undisturbed in their natural state. The fern growth of the Graves Grove is luxuriant and dense, and the accompanying growth of Douglas fir, tanbark oak, and rhododendron presents a further aspect of interest in the new acquisition.

Henry S. Graves, in whose honor the tract will be dedicated, is one of the foremost figures in the history of American forestry. From 1900 to 1910 he served as Professor of Forestry at Yale, resigning this post in that year to become Chief of the United States Forest Service, a position he held until 1920. In 1922 he returned to Yale as Dean of the School of Forestry there. He is now Provost of Yale University. During the years of his connection with the United States Forest Service and Yale University, Colonel Graves has been vigorously active in forest exploration and survey work in the United States and Alaska. Dividing his time between academic duties and the outdoors, he became alike a plainsman and mountaineer and an authority on policies of forest conservation and maintenance of scenic assets in their relation to forestry. During the World War he served in France as Lieutenant-Colonel in the Engineer Corps.

The Graves Grove will be an addition to the State Redwood Park System, in which notable areas have been established by the private donations and contributions of tree-lovers throughout the United States. Existing groves added in this way are the Franklin K. Lane, Bolling, Edwin R. Hickey, Stephens, Richardson and Humboldt County Pioneer Groves. The Save the Redwoods League, the organization which was instrumental in securing the present nucleus, now includes a membership of more than 5,000, and through further large donations similar to that from Mr. Schwarz, plans additions to the area of preserved redwoods which will form a continuous chain of giant trees along much of the famous Redwood Highway.

George F. Schwarz, who, with the League, furnished the funds for this grove, was at one time an official in the United States Forest Service, is a writer on the scenic aspects of forestry, and as a result of his forestry experience felt keen interest in the preservation work of the Save the Redwoods League.

A WORLD'S FORESTRY CONGRESS

By agreement between the International Institute of Agriculture and the Italian Government a committee has been established for organizing a World's Forestry Congress to take place in Rome early in May, 1926. The headquarters of this committee are at the International Institute of Agriculture in Rome, and the committee is composed as follows: President, Prof. Arrigo Serpieri, Director of the Royal Higher Institute of Agriculture and Forestry at Florence, Member of the Italian Government; Vice-Presidents, M. Anders Fjelstad, Delegate of Norway at the International Institute of Agriculture, and Dr. Alessandro Stella, Director General of Forests and State Lands at the Italian Ministry of National Economy; Secretary, Sig. Ariberto Merendi, Chief Inspector of Forests at the Ministry of National Economy; M. Deoclecio de Campos, Delegate of Brazil at the International Institute of Agriculture, Sig. Gian Francesco Guerrazzi, Delegate of Italian Somaliland at the Institute, and Prof. Asher Hobson, Delegate of the United States of America at the Institute.

The congress will bring together experts in forestry and the timber and allied industries from all parts of the world, and it is hoped that truly valuable and profitable results will be reached through the exhaustive discussions, which are expected to take place on all those problems of forestry which are of really international importance.

At the same time, in connection with the International Fair at Milan, there will be held an important exhibition of forest products and the machinery used in their conversion, which will enable visitors to examine the different products of the wood manufacturing industries and the wood working machines made in the various countries, and should serve to increase the flow of international trade in this important branch of commercial activity.

Various excursions to the more typical forest lands in Italy, and possibly in other countries, will be arranged to follow the work of the congress.

The congress is already arousing the warmest interest as it is considered to be the most important event in connection with forestry and the allied industries that has as yet taken place.

CO-OPERATORS APPOINT EXTENTION FORESTER

Beginning October 1, Minnesota farmers and timber owners will have the help of a university extension specialist in forestry in solving their problems and forwarding their enterprises. Parker Anderson, a graduate of the School of Forestry, University of Minnesota, has been appointed Extension Forester with headquarters at University Farm. Four agencies are co-operating in this new service—the agricultural extension service of the University, the State Department of Forestry, the division of forestry in the Agricultural College, and the United States Department of Agriculture. The objects are to assist owners of farms in establishing and maintaining woodlands, shelterbelts, windbreaks, and other forms of forest growths, in growing and renewing useful timber crops, and in marketing and utilizing such crops. Demonstrations in the best forest practices will be established in connection with the county extension organization. These will be supplemented by field meetings, exhibits, personal conferences, lectures, correspondence and publications.

SIR WILLIAM SCHLICH 1840 — 1925

Sir William Schlich died on October 1 at his residence in Oxford at the age of 85. From Germany, the country of his birth, he brought to England, the country of his adoption, an enthusiasm for forestry. It is largely owing to his labors, continued for more than 50 years in India, at Coopers Hill, and at Oxford University, that forestry was raised to its present position throughout the British Empire as a recognized science. Few foresters have done more, alike by their own

energies and by their inspiration of others. No doubt, much of his success was due to his remarkable powers of organization, but his two chief secrets were simply that he loved forestry and that he loved his pupils.

Professor Schlich was elected honorary member of the Society of American Foresters in 1924. We hope, in a later issue of the Journal, to give a fuller account of his life and his contribution to forestry.

GUNNER SCHOTTE

We regret to announce that Professor Gunnar Schotte, Director of the Swedish Institute of Experimental Forestry, and corresponding member of the Society of American Foresters, died on the 28th of August at the age of 51 years. His death is a severe blow as it comes at the height of an active life, ardently devoted to the furtherance of the science of forestry in Sweden.

An appreciation of his work, it is hoped, may be published later in the Journal by some of his colleagues.

SOCIETY AFFAIRS

NEW ENGLAND SECTION

The New England Section held its summer meeting and outing in York County, Maine, with headquarters at Old Orchard on August 3, 4 and 5, with about sixty present.

The first day was spent in Hollis on lands of W. B. Deering, a local lumber operator, who has been carrying out various ideas of forest management on his property, some his own and some on the advice of technical friends, and has obtained some very interesting results.

The second day was spent in portions of the Bates College Forest in Alfred, a tract of 12,000 acres bequeathed to the college about 10 years ago. This forest, under the management of Forester Randall, is carried on on a self paying basis and combines in a very interesting manner a scientific and a practical forestry program.

The third day was given over to a steamer trip on Casco Bay and a short visit to the summer home of Austin Cary. One business meeting was held in the evening, with the discussion turned largely to the salaried secretary proposition for the Society and the final straw vote was largely in favor of increasing the dues to \$10 and \$20 to make such a plan possible.

Nine new members were nominated to the Society and three proposed for advancement to the senior grade.

H. O. COOK, *Secretary*

NEW YORK SECTION SHOWS THE WAY

At the summer meeting of the New York Section held at Ithaca, June 16th and 17th, it was voted to contribute the sum of \$100 to the Society towards a fund for the employment of a permanent paid secretary. The only condition attached to this action was that this money would not be forthcoming until after the annual meeting of the section in February, 1926.

The Section rather hopes that its action may be followed by other Sections as indicating the support of this means of developing the Society, and the desire of the various Sections to work in closest possible co-operation with the national officers in their efforts to put the Society of American Foresters on the same high plane as that enjoyed by other national engineering organizations.

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